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Nature

A WEEKLY

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

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THURSDAY, MARCH 4, 1915.

TIME AND SPACE.

A Theory of Time and Space. By A. A. Robb. Pp. vi + 373. (Cambridge University Press, 1914.) Price 10*s.* 6*d.* net.

THE appearance of Dr. Robb's treatise, if such a word can be applied to a volume which opens out a new field of philosophical inquiry on the basis of modern physical science, is a very welcome event, and more especially to students of the fundamental nature of the conceptions which we employ in our attempts to describe physical experiences. There is a general feeling, at least in this country, that in spite of the remarkable success of the principle of relativity in simplifying our descriptions of physical science, the more logical aspect of the principle is seriously at fault, and herein lies the reason for the noticeable decline in favour which the principle has experienced recently. The present work, as its title implies, is a definite *theory* of space and time, and although its aim is strictly logical throughout, it deals with its subject in a simple geometrical manner, readily followed by anyone who has made a study of Euclid. The author's selection of a model is very judicious, and makes the argument flow so smoothly that the reader will probably realise with a shock, at some point, the far-reaching nature of the conclusions to which he has been led.

The author had already published the introduction to the work as a tract, but it is reproduced in the present volume. It gives a brief statement of the history and essential meaning of the principle of relativity, pointing out the more important difficulties which are felt, and which the more formal treatises on the principle, by tending to emphasise unduly the purely mathematical aspect, do not attempt to meet. As is well known, relativity demands that events which are simultaneous events for one observer are not necessarily so for another. This is at variance with the fundamental principles of logic, which demand that "a thing cannot both be and not be *at the same time*." But the simplicity brought about by the introduction of such postulates is such that physicists have allowed them to pass for a time, always, however, realising that our ideas of space, and more especially of time, must be so modified as to make them intelligible and part of a logical system. This simple example will illustrate the scope of Dr. Robb's work, and the exact manner in which it differs fundamentally from the more usual treatises. He has shown that, as a corollary from his treatment of space and time relations, such a logical scheme of geometry and of time can be built up, in which our ordinary geometries find a place.

The foundation of the work involves a new idea —that of *conical order.* The spacial relations are to be regarded as the manifestation of the fact that elements of time, or instants, form a system in conical order. This conception may be analysed in terms of the relations of *after* and *before.* From some twenty-one postulates involving these relations it is possible to set up a system of geometry in which any element can be represented by four co-ordinates, x, y, z, t. The first three correspond to space co-ordinates, and the fourth to time as generally understood. But since an element in this geometry corresponds to an instant, and bears the relations of after and before to other instants, the theory of space appears as a part of the theory of time. Simple geometrical interpretations of the initial postulates in three dimensions are given in the volume. One remarkable feature is that it seems necessary for a really consistent theory to limit the number of dimensions to four. The geometrical system is developed to a considerable extent, and is left at a point from which it may be easily carried in its correspondence with the whole range of ordinary geometrical detail.

The investigation is made in connection with the phenomena of optics. This is, of course, necessary in any attempt to analyse the foundations of any space and time theory. The view taken is that the axioms of geometry are mainly the formal expression of certain optical facts, and the author rightly points out the defects in systems some of the axioms of which have this significance, while others depend on such things as the properties of purely ideal rigid bodies. The significance of all axioms in a logical scheme must be of the same character, and the optical character is the only legitimate one we have at our disposal.

It is not possible in a review to give any account of the detailed working out of these ideas. It can only be said that their development is extremely elegant, and is worthy of being taken as a model for any type of geometrical work. The book is in the standard form of the Cambridge University Press, and bearing in mind the traditional excellence of this series, it is perhaps superfluous to say that the tradition is well maintained in the present case.

APPLIED MECHANICS AND AMERICAN TIMBERS.

The Mechanical Properties of Wood. By Prof. S. J. Record. Pp. vi+165. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 7*s.* 6*d.* net.

TO those unfamiliar with the composition and construction of wood it comes as a matter of surprise that the "hardness," calorific value, also, to some extent, the strength and certain other mechanical qualities, are proportional to the apparent specific gravity. Yet the unexpectedness of these relations vanishes when it is realised that a piece of completely dried wood contains, in addition to air and insignificant amounts of various substances, wood-substance the specific gravity of which is approximately (or truly?) the same in all kinds of woods. Two pieces of dry wood of the same volume thus differ in weight nearly solely because one contains more wood-substance than the other. Wood is not a material, but is a heterogeneous and varied structure, and its particular mechanical properties are dependent not merely on the amount of wood-substance contained in its unit of volume, but also on the manner in which that substance is excavated in the form of strong fibres, weak vessels, and so forth. The arrangement, form, and numbers of these constituents vary widely in different kinds of timbers, with the result that these display corresponding differences in their mechanical properties.

In view of Prof. Record's botanical work on the structure of the woods of the United States, it might have been anticipated that the book under review would deal considerably with the interesting, and incompletely investigated, problems concerning the correlation between the structure and properties of timbers. Very different, however, are the scope and contents of the book, the subject matter of which includes, in order, a brief account of the elementary mechanics of materials, a special consideration of the mechanical properties of wood and of the factors influencing them, and a description of the methods of wood-testing officially adopted in the United States. It gives concise information as to facts gleaned particularly in that country from experiments conducted along the lines laid down by workers in Austria, Germany, and Switzerland; and the information is illustrated by well-chosen figures, including photographs.

The book, however, is akin to a collection of lecture notes dealing with actual experimental results obtained, rather than to a reasoned exposition of the subject. The resultant curtailment is consequently apt at times to lead the student into lack of comprehension or to misconception. The latter is the case when two definitions of hardness are given, the second being "resistance to abrasion or scratching." The truth is that when measured by abrasion the resultant estimates of hardness agree with those obtained by indentation tests and everyday experience with a saw; whereas when tested by scratching all woods are approximately of the same degree of hardness, and that degree is a low one (about equal to muscovite). One feature that takes from the value of the book to English students is that in it, as unfortunately in an increasing number of American scientific books, the language, terminology, and nomenclature are partly foreign to England. Not only are the timbers mentioned exclusively under American names, but popular technical terms unknown in this country are employed, and scientific definitions do not at times accord with those in use here. For instance, a unit stress is defined as "the stress on a unit of sectional area." (Not thus explicable is the erroneous statement on the same page that a "stress-strain diagram" is "a diagram or curve plotted with the increments of load or stress as ordinates, and the increments of strain as abscissæ"; the curve in question supplied shows that the words "increments of" should be omitted.)

In addition to the well-illustrated account of the methods of wood-testing adopted by the U.S. Forest Service, a useful bibliography of the subject, and particularly a list of less-known American papers, gives value to the book. P. G.

WATER REPTILES.

Water Reptiles of the Past and Present. By Prof. S. W. Williston. Pp. vii+251. (Chicago: University of Chicago Press; London: Cambridge University Press, n.d.) Price 12*s.* net.

JUST as it is clear that the existing whales and porpoises are descended from quadrupeds which formerly lived on land, it is gradually being recognised that the marine reptiles which occupied their place during the Secondary Period of geological time also had land-ancestors. Many of the connecting links can now be traced among the fossils discovered during recent years, and so much progress has been made in interpreting them that it is interesting to pause and survey the result. The original papers are scattered through special journals, some of them not easily accessible, and it is necessary to collect the essential facts from numerous sources. We therefore welcome the small book by Prof. Samuel W. Williston, who has devoted many years to the successful study of these reptiles and now reviews the subject exhaustively with first-hand knowledge.

Though the work is mainly suited for students who have some preliminary acquaintance with vertebrate palæontology, Prof. Williston hopes to attract more general readers by a series of introductory chapters dealing with a few elementary geological considerations, and with the structure of the reptilian skeleton and its various modifications in those animals which are adapted for life in water. He then treats the groups of water reptiles in systematic order, referring to the few that survive as well as the great tribes of extinct forms. The descriptions are illustrated both by drawings of the skeletal remains themselves and by many spirited restorations, some original and others by well-known authorities. The technical accounts of structure, indeed, are followed in all cases by a discussion of the inferences they suggest as to the habits and mode of life of the animals in question. All the chapters are well up-to-date, and that on the Cretaceous Mosasauria is especially interesting from its intimate connection with the author's own researches.

As we turn over the pages of this book we are led to speculate as to why nearly all these groups of water reptiles, so widely distributed in every sea, suddenly became extinct at the end of the Secondary Period, without coming in contact with the whales and porpoises which in later times took their place. Prof. Williston can only suggest that the races may have become effete and died of old age. It is evident that the mystery still awaits solution. A. S. W.

MIND AND MATTER.

(1) *The Master-Key: a New Philosophy.* By D. Blair. Pp. 118. (Wimbledon: Ashrama Agency, 1914.) Price 3*s.* 6*d.* net.

(2) *Essays on the Life and Work of Newton.* By A. de Morgan, edited by P. E. B. Jourdain. Pp. xiii+198. (Chicago and London: The Open Court Publishing Co., 1914.) Price 5*s.* net.

(3) *The Analysis of Sensations and the Relation of the Physical to the Psychical.* By Dr. E. Mach. Translated by C. M. Williams. Pp. xv+380. (Chicago and London: The Open Court Publishing Co., 1914.) Price 6*s.* 6*d.* net.

(4) *Proceedings of the Aristotelian Society.* New series, vol. xiv. Pp. 438. (London: Williams and Norgate, 1914.) Price 10*s.* 6*d.* net.

(5) *The Philosophy of Change: a Study of the Fundamental Principle of the Philosophy of Bergson.* By Dr. H. W. Carr. Pp. xii+216. (London: Macmillan and Co., Ltd., 1914.) Price 6*s.* net.

(1) THE writer condemns himself by his own pretensions. He calls his system a "new philosophy," and is writing another book—"The Truth about the Other World"—which "will be the first genuine Revelation ever published." In the volume under notice he discusses all things in heaven and earth, from the solar spectrum, heredity, and space, to Platonism, hallucinations, and Vedanta. There is evidence of a great deal of heterogeneous and elementary knowledge, but all is confused and superficial. Apparently the author finds salvation in the word Monad—though he does not expound Leibniz—but his explanations do not explain much. He posits a "nerve-ether" which is quite different from the luminiferous æther, which latter is "no use" to him; and he seems to have a very poor opinion of the Royal Society. No doubt the society will survive.

(2) These reprinted essays, written more than half-a-century ago, are still worth reading, both for their matter and their style. De Morgan was an able mathematician, he made careful researches into the details of Newton's life and controversies, and he had a very characteristic wit. His treatment of Newton is respectful yet critical. Sir

Isaac was not the almost superhuman moral paragon which for long it was the fashion to suppose him; he had a petulant dislike of opposition, a tendency to keep his discoveries to himself instead of letting the world have the benefit of them —in which he compares badly with the frankness of Leibniz—and a rather mean revengefulness, as in his treatment of Flamsteed, whose observations had been pre-eminently useful to him. On the other hand, De Morgan readily acclaims him as the greatest scientific genius of all time, and indeed above the average level of his time as to character also. His protest is merely against excessive veneration. Section viii. of the last essay is on Newton's religion, which has been the subject of much debate. The Unitarians claim him, and, in spite of Brewster, they are probably right.

There is a small mistake in the footnote on p. 21—"Uranus" should be "Neptune"—but we mention it only in order that it may be put right in the next edition. We see no other slips, and the editor is to be congratulated on a piece of good work.

(3) This book is not so much a new edition of the English translation of Prof. Mach's "Contributions to the Analysis of the Sensations," published in 1897, as an entirely new work; for it is considerably enlarged. Its contentions, however, are the same, and the expansion is in the details. Mach disclaims the title of philosopher, considering himself a physicist; but inasmuch as he seeks a unifying principle applicable to all sciences, he philosophises. According to his view, all experience is made up of elements which are best regarded as of one kind. The distinction of material and psychical, of subject and object, is mischievous. All experience is of one stuff, and the task of science is to investigate relations. A psychical fact is as real as a material fact; indeed, each element exists in both the worlds, according to our purposes of the moment. And as this web of experience—and its threads of relations—is all that we need concern ourselves with, we can throw overboard the *Dinge an sich* which modern philosophy inherits from Kant, and with these useless *noumena* lying behind material phenomena we can throw overboard the *noumenon* which lies or was supposed to lie behind our own mental phenomena.

This radical abolishment of the ego is the main difficulty. Mach counters the inevitable question "*Who* experiences?" by saying that the question itself shows the questioner to be still in the bonds of the fatal habit of subsuming every element (sensation) under an unanalysed complex (p. 26), and this is admittedly a neat and suggestive answer. It does not prove that there is nothing in that complex but its elements and their relations, but, on the other hand, the ego-advocates cannot prove that there is something. J. S. Mill reached this same stalemate, being unable to see how a chain of memories can be conscious of itself. ("Examination of Sir William Hamilton's Philosophy," particularly the chapter on the "Psychological Theory of an External World.") The fact is that we can no more circumnavigate and exhaustively comprehend the totality of our own self, than we can lift ourselves off the ground by pulling at our own bootstraps. It follows from this, and quite harmoniously with Prof, Mach's principles, that our attitude towards possible survival of death should be entirely non-committal, so far as *a priorism* is concerned. He himself decides against it, somewhat vehemently—which perhaps indicates human prejudice overcoming philosophic calm. But he writes for the most part with a saving humour and modesty, and in moments of quiet reflection he would probably admit that his "Weltanschauung" does not necessitate the annihilation of the large complex which is himself, when the portion of that complex which he calls his body is detached.

(4) The Proceedings of the Aristotelian Society are for exceedingly athletic thinkers, and are probably the cause of many headaches even to them. The papers are highly technical, and in so far as they are philosophic rather than scientific, they do not call for detailed review in NATURE. The present volume contains, among other things, the following: "Appearance and Real Existence," by G. Dawes Hicks; "William of Ockham on Universals," by C. Delisle Burns; "Philosophy as the Co-ordination of Science," by H. S. Shelton; "Intuitionalism," by N. O. Lossky; "Discussion —The Value of Logic," by A. Wolf and F. C. S. Schiller; "The Psychology of Dissociated Personality," by W. Leslie MacKenzie (who inclines too much to Münsterberg and Freud, and does not mention F. W. H. Myers); "Freedom," by S. Alexander; "The Status of Sense-Data," by G. E. Moore and G. F. Stout; and "The Principle of Relativity," by H. Wildon Carr, who discusses difficulties about the objectivity of the æther, etc., and finds absolute reality in life or consciousness itself only.

(5) Probably no one can read M. Bergson without feeling the fascination of his style and the persuasiveness of his apt imagery; and the same is true of his chief disciple and expounder in this country. Mr. Carr gives us a sincere and careful account of the new philosophy as he sees it, emphasising its fundamental stress on change, and pointing out that with regard to science it is

neither contemptuous like Hegelianism nor degraded to a servile co-ordinator as in the positivism of Comte and Spencer, but is equal and friendly, bringing a new method of its own for the attainment of further truth. This intuitional method requires a great effort at the outset, he admits; for it involves a turning away from the intellectual methods of the last 2500 years. After reading this book of Mr. Carr's and the whole of M. Bergson's published writings, one reviewer at least feels that while M. Bergson is undoubtedly trying to express what is very real and true to him—and doing it in beautiful language—the thing is difficult and almost impossible, because the philosophy consists of an attitude, so to speak —or of a vividness of personal experience, which is incommunicable. Mr. Carr denies that it is mystical, and, taking some senses of that much-abused word, he is no doubt right; but it is mystical in its anti-conceptualism, and is essentially allied to various Oriental systems. It is a grafting of East on West, including the excellences of both. Perhaps at bottom it is a release from old fetters rather than a new doctrine. A heterodoxy does its chief good not by bringing new truth, but by cancelling out old error, and allowing the mind to go forward unencumbered. J. A. H.

OUR BOOKSHELF.

Panama, the Canal, the Country, and the People. By Arthur Bullard (Albert Edwards). Revised edition. Pp. xiv+601. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8s. 6d. net.

MR. BULLARD (Mr. Edwards of the first edition) has brought his sketch of Panama up-to-date by the addition of chapters describing the progress of the canal since 1911. The book consists chiefly of two parts, first a history of the State of Panama, and secondly a very pleasant description of the life of the Americans during the last ten years in the huge construction camp on the canal line. This life was well worth description, being truly a remarkable phenomenon. In the midst of a tropical wilderness, far from their own country, and in a pestilential climate, a labour-camp of fifty thousand hands settled at once to an orderly and civilised life, and, under the protection of a medical despotism, enjoyed on the whole excellent health.

Mr. Bullard provides character sketches of the principal constructors—Colonel Goethals, Colonel Sibert, Doctor Gorgas, and the rest, including Mr. Comber, the dredging expert, who is responsible, under Colonel Goethals, for most of the work now going on. This consists in the removal of the material which comes into the Culebra cut from the breaking ground along a length of about two miles near the deepest part of the excavation. Part of it slides in from above, part of it squeezes up from below under pressure from the sides. It is this latter movement which is so disquieting. In one or two cases ships have gone aground before it was known that there had been an upheaval beneath the opaque and muddy waters of the canal. Some years may elapse before the Culebra cut is stable; meanwhile, the canal is used, though not without interruption, and the whole of the complicated lock machinery works without a hitch.

V. C.

Catalogue of Scientific Papers. Fourth Series. (1884–1900.) Compiled by the Royal Society of London. Vol. xiv. C—Fittig. Pp. 1024. (Cambridge University Press, 1915.) Price 2l. 10s. net.

THE first volume of the fourth series of the Royal Society's Catalogue of Scientific Papers was noticed in the issue of NATURE for August 20 last. It was pointed out on that occasion that this series comprises the titles of papers published or read during the period 1884–1900, and concludes the work undertaken by the Royal Society. The catalogue thus completed will contain titles of papers for the whole of the nineteenth century. It will be remembered that the continuation of the work is now undertaken by the authorities of the International Catalogue of Scientific Literature.

The present volume contains 24,994 entries of titles of papers by 4351 authors with the initial C, 17,665 entries by 3072 authors with the initial D, 7750 entries by 1368 authors with the initial E, and 6646 entries by 1230 authors under F, as far as Fittig. The total for the first two volumes of the series is 108,775 entries by 18,950 authors.

It is to be hoped that the series of volumes will be added to every reference library of importance throughout the world, so that the public-spirited conduct of the publishers, who have undertaken the complete risk of printing and publishing, may not result in financial loss.

What do We Mean by Education? By Prof. J. Welton. Pp. xii+257. (London: Macmillan and Co., Ltd., 1915.) Price 5s. net.

PROF. WELTON'S question has been heard in every direction since the war began; and perhaps the outstanding characteristic of the answers which have been offered is the almost complete disagreement among them. Most competent persons will agree with Prof. Welton that "an investigation into fundamental principles" is necessary before a satisfactory reply to the question can be given. This book undertakes such an inquiry, and certainly the reader who follows the argument to the end will leave the volume with much clearer ideas on the subject. The titles of the chapters indicate the trend of the discussion: "The end rules the means"; "What should be the end?"; "Synthesis of liberty and authority"; "What are the means?"; "Who are the agents?" Though difficult reading in parts, the volume deserves the careful attention of teachers and educational administrators.

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 Spectra of Hydrogen and Helium.

IN a letter to NATURE of February 11, Prof. J. W. Nicholson discusses the recent interesting experiments of Mr. Evans on the spectrum emitted from a vacuum tube containing highly purified helium and subject to a heavy discharge. Evans found that the 4686 series and the Pickering series can be obtained in a helium spectrum showing no trace of the ordinary hydrogen lines. These series were observed a few years ago by Prof. Fowler by sending a heavy discharge through a mixture of hydrogen and helium; previously they had been observed only in star spectra. In addition, Evans observed that under the same conditions as the 4686 series and the Pickering series a new series of lines appeared, which, with regard to position and intensity, could be united with the Pickering series into a single series of the same type as the 4686 series. The lines of the new series have wave-lengths very close to the hydrogen lines of the Balmer series. In his letter Prof. Nicholson expresses the opinion that Evans's results cannot be used to discriminate between the different theoretical interpretations of the spectra in question, since the new series as well as the Pickering series can be deduced from the 4686 series on the general principle of combination of spectral lines. I cannot agree with this view, and should like here to state my reasons.

According to the theory proposed by Rydberg, and generally accepted for a long time, all the lines in question are ascribed to hydrogen. This theory is based on a supposed analogy between the hydrogen spectrum and the spectra of the alkalies. The Balmer series, the Pickering series, and every second member of the 4686 series are considered as diffuse series, sharp series, and principal series.

According to the theory proposed by the writer, the series spectrum of hydrogen is simply represented by the formula

$$\nu = K\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \quad . \quad . \quad . \quad . \quad . \quad (1)$$

including only the Balmer series, the Ritz series in the ultra-red, and the series in the ultra-violet recently observed by Lyman. The other series are all ascribed to helium and represented by the formula:

$$\nu = 4K'\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \quad . \quad . \quad . \quad . \quad . \quad (2)$$

including the 4686 series, the Pickering series, and Evans's new series. K′ is not exactly equal to K, though very nearly so, the theoretical value for the ratio K′/K being 1·00041. The theory rests upon a certain application of the quantum theory to the theory of the nucleus atom, and essentially involves the combination principle. While the ordinary helium spectrum is supposed to be emitted from a helium atom which has lost a single electron, spectrum (2) is emitted, according to the theory, from a helium atom which has lost both its electrons. If spark spectra result from the removal of two electrons from the atom, formula (2) should correspond to the spark spectrum of helium, while hydrogen, which is supposed to have only one electron in the atom, cannot give a spark spectrum.

Since the numerical relations between the different series claimed by the two theories are not exactly the same, it would be possible at once, as mentioned by Prof. Nicholson, to discriminate between the theories if the wave-lengths of the lines were exactly known. It seems that both the measurements of Fowler and Evans are in close agreement with formula (2), but that it would be difficult to reconcile Evans's redetermination of the wave-length of the Pickering lines with Rydberg's assumption that the Balmer series and the Pickering series have the same limit. Quite apart, however, from the question of the exact numerical relationship between the series, it seems that fundamental difficulties in Rydberg's view are brought to light by the experiments of Fowler and Evans. Fowler's observation that the 4686 series contains twice as many members as the series predicted by Rydberg, and Evans's observation of the new series accompanying the Pickering series, destroy completely the simple analogy with the alkali spectra which forms the basis of Rydberg's theory. If, as Prof. Nicholson proposes, we look upon the Pickering series and the Evans series as a simple combination series deduced from the 4686 series, the contrast with the alkali spectra seems even more striking, since then apparently no sharp series is observed. On the other hand, it will be noticed that this simple relation between the series is an immediate consequence of formula (2), and that Evans's observation makes the representation of this formula more complete than before since only every second member of the series corresponding to $n_1 = 4$ was previously observed.

I must confess, however, that perhaps the strongest objection to Rydberg's view seems to be the entirely different chemical conditions for the appearance of the Balmer series and the other series, so clearly shown by Evans's experiments. This difference has no analogy in the appearance of the diffuse series in the alkali spectra. I am afraid that it may not seem reasonable to emphasise this objection so strongly, since it, of course, has been contemplated by spectroscopists ever since the theory was proposed, but it appears that the basis for the consideration of this question recently has entirely changed. Rydberg's theory of the hydrogen spectrum offered not only an adequate representation of the evidence at hand at that time, but it was apparently the only way to bring the Pickering series into line with Rydberg's own fundamental investigations on the general relations between spectral series. However, Fowler's recent important work on series in spark spectra has shown that these spectra obey laws of exactly the same character as the ordinary arc spectra, with the only exception that the Rydberg constant is replaced by a constant four times as large. Consequently formula (2) corresponds to the general formula for series in spark spectra exactly as formula (1) corresponds to the general formula for series in arc spectra. It would therefore appear that at present there is scarcely sufficient theoretical evidence to justify us in disregarding the direct evidence as to the chemical origin of the lines given by Evans's experiments.

It may be of interest in this connection to mention that the above conclusions seem to be supported by spectroscopic evidence of an entirely different character. Recently Dr. Rau (*Sitz. Ber. d. Phys. med. Ges. Würzburg*, 1914) has made some interesting experiments on the minimum voltage necessary to produce spectral lines. He finds that about 30 volts are necessary to produce the lines of the ordinary helium spectrum, and that the voltage necessary to produce the different lines and series in this spectrum differ only by a few volts. On the other hand, he finds that the lines of the Balmer series appear with a voltage of only about 13 volts, while about 80 volts are necessary to produce the lines of the 4686 series and the Pickering series. According to the theory of the writer, the energy necessary to remove the electron from the hydrogen atom corresponds to a fall of an electron through a potential difference of 13·6 volts, while the energy to be used in removing one electron from the helium atom corresponds to a fall of 29·0 volts, and in removing both electrons to a fall of 83·4 volts. N. BOHR.

Physical Laboratory, University of Manchester, February 21.

X-Ray Fluorescence and the Quantum Theory.

THE experimental conclusions which I briefly outlined in a letter to NATURE of February 18 point directly to a theory of X-ray fluorescence and of the emission of radiation in quanta, which certainly bears a resemblance to Bohr's theory of line spectra. The experimental evidence obtained is, however, so direct that there seems little possibility of escape from the conclusions given below. Indeed, the theory was forced upon the writer directly by the experimental results, and it was only afterwards that he was reminded of some similarity with the theory of Bohr based on the Rutherford atom.

It is an experimental fact that in the case carefully investigated (and obviously in many, if not in all, other cases), the ejection from an atom of an electron associated with a fluorescent X-radiation of frequency n necessitates an absorption of energy greater than the kinetic energy carried away by the electron by approximately the energy (hn) of one quantum of radiation of frequency n. Thus :—

(1) Total absorption per electron emitted $=\frac{1}{2}mv^2+hn$ (approximately)—that is, the energy required to separate the electron (a K electron, say) from the parent atom, is approximately equal to the energy of a quantum of the fluorescent radiation of series K associated with that electron.

The energy of a quantum of radiation may therefore be regarded as the mutual potential energy of the separated atom and electron, measured from the zero given by the electron in its normal position and state. When the displaced or any other electron falls back into the position of the displaced electron, the energy is re-emitted as a radiation characteristic of the atom, and this, of course, in definite quantity. So much may be claimed as at any rate giving a first approximation to the truth. The results of experiments, however, suggest the possibility of the necessity for some modification of this theory in detail, though not in principle. For in the one case thoroughly investigated we get a nearer approximation to the experimental results by writing

(2) Total absorption per electron emitted $=\frac{1}{2}mv^2+hn_K+hn_L$, where n_K and n_L are the frequencies of the K and L fluorescent radiations respectively. As the third term (hn_L) is at its maximum value only about 7 per cent. of the whole, it is impossible at this stage to say definitely whether or not it expresses a physical fact. This term was, however, suggested by a consideration of the probable process following the ejection of a K electron. The relation indicates that *possibly* the energy required to free a K electron is equal to the sum of the energies of quanta of K, L, and any other fluorescent radiation of lower series M, N, etc.—presumably originating in vibrations in the outer rings of the atom.

If we accept this provisionally it means that the energy of a quantum of K radiation is that required to displace a K electron into the position of an L electron, while the energy of a quantum of L radiation is that required to displace an L electron into the position of an M electron, and so on. Such a process may never occur; it is, however, a convenient way of expressing the energy required completely to eject the electron in terms of steps which can only be regarded as extremely probable in the inverse process involving radiation.

Thus the energy of a quantum of K radiation is left in the atom from which a K electron is hurled; or *possibly* the energies of one quantum of each of the fluorescent radiations, K, L, M, etc., are left in the atom. This energy must, of course, be radiated while the atom is regaining its original configuration by the absorption of an electron into the K position. It seems probable, however, that the readjustment of the atom and the principal radiation take place even before the atom as a whole regains an electron, by an L electron falling into the position of a displaced K electron, an M electron replacing an L electron, and so on; only the final stage of the readjustment being completed by the absorption of an electron into an outer depleted ring.

It is obvious in this case—unlike that studied by Bohr—when and why an electron falls into an inner ring; it is simply subsequent to and due to the removal of an inner ring electron. No new principle of radiation is involved, yet it accounts for radiation taking place in quanta. We should thus expect L radiation to be associated with the emission of K electrons as well as with L electrons. Search for such a radiation is at present being made. Pointing to the probability of such an associated radiation is the fact that when hn_L becomes a smaller fraction of the whole absorption, the discrepancy found when it is omitted, as in equation (1), diminishes. Not only is this so, but the energy of the corpuscular radiation and of the K fluorescent radiation actually emitted, do not quite fully account for the whole energy absorbed. The discovery of the L radiation in calculated intensity would give almost perfect agreement.

In spite of these indications the writer hesitates to make a definite statement about the physical reality of the third term concerned with L radiation; experiments will very soon decide the point.

In either case we have the direct evidence that the energy of a quantum is simply energy absorbed in removing the corresponding electron from its normal orbit; it is the energy afterwards set free, presumably when the electron returns.

It is hoped that experiments now being undertaken will determine also if X-ray fluorescence—that arising from the vibration of inner ring electrons—can be appreciably delayed by retarding the return of the ejected or other electrons from outside the atom. It is more probable that X-ray *phosphorescence* will not be detected, the readjustment of the interior of the atom taking place immediately after the ejection of an inner electron, and the final absorption of an electron into a surface ring being the only part of the process susceptible to external conditions. The subject can, however, only receive adequate treatment in communications to other journals. C. G. BARKLA.

University of Edinburgh, February 27.

The Physical Properties of Isotopes.

PROF. SODDY's letter in NATURE of February 4 would seem to lead to certain interesting conclusions about the structure of the atom. It is easy to show that two elements of different atomic weight must differ either in their chemical or in their physical properties. If elements are inseparable chemically their affinity A must be equal. Now $A=-T\int_0^T \frac{U}{T^2}dT$ if T is the temperature and $U=\int_0^T C_p dT$, where C_p is the atomic heat.

The fact that emerges most clearly from all the work done on this subject is that the atomic heats of similar substances may all be represented by the same function $f(\nu)$ of the atomic frequency ν. Therefore, if A is the same for isotopes, and this would seem to be the definition of the word, their atomic frequencies must be identical. But as ν is a function of the atomic weight and of the forces acting between the atoms, the latter must vary when the atomic weights are different. If the force of attraction between two atoms is $a\phi(r)$ and the repulsive force $b\psi(r)$, r being the distance, then at a sufficiently low temperature the quasi-elastic force holding an atom in position is $a=2k(a\phi'(r)-b\psi'(r))$. The constant k represents the action of the surrounding atoms and depends only upon the type of space-lattice formed by the atoms. As the atomic frequency $\nu=\frac{1}{2\pi}\sqrt{\frac{a}{M}}$ is the same for all isotopes, $\frac{a\phi'(r)-b\psi'(r)}{M}$ must be identical, whatever the atomic weight M may be. As Prof. Soddy has shown that the atomic volume and consequently r is also constant, it follows that both a and b must be proportional to the atomic weight.

This conclusion might, perhaps, be tested by a measurement of the vapour pressure of the different sorts of lead. The latent heat of sublimation λ is proproportional to $a\int_r^\infty \phi(r)dr - b\int_r^\infty \psi(r)dr$, that is to M, as r is the same in both cases. The well-known equation $\lambda=RT^2\frac{d\ln p}{dT}$, where p is the vapour pressure, leads to $e^{\frac{\lambda_1-\lambda_2}{RT}}$ as the ratio of the vapour pressures, if the chemical constant is equal. This is of the order $e^{\frac{68}{T}}$ if M varies by 0·26 per cent, *i.e.* about 20 per cent. at 100° C. The vapour pressure of radium D the atomic weight of which is 210 should be about $e^{\frac{360}{T}}$ times less than that of ordinary lead, that is, 2·6 times less at 100° C.

Another posible test would be to measure the melting point. In a great many cases $\nu=\text{const.}\sqrt{\frac{T_m}{Mr^2}}$. As ν cannot vary, and as Prof. Soddy has shown that r is constant, the melting point T_m should be proportional to M. Thus, for instance, the melting point of Prof. Soddy's lead should be 1·54° higher than that of ordinary lead. In all probability the atomic weight of the final product of thorium is 208·4, in which case the difference in the melting point should be as much as 3·75°. These consequences are not necessary but, admitting the absolute chemical identity, highly probable. They include the assumption that the radii of the atoms are equal as well as their mean distance apart in the solid state. In any case, a measurement would seem well worth while, as a negative result would be of almost as great interest as if a difference were observed. Unfortunately, the elastic constants which should vary by a corresponding amount can scarcely be measured with sufficient accuracy.

The following conclusions about the structure of the atom would seem to result. The purely chemical properties are determined by the external electrons which probably also account for the apparent radius of the atom. The forces of attraction and repulsion between the atoms, the interaction of which results in the solid state, have their origin in the nucleus. In isotopes they are proportional to the atomic weight, *i.e.* probably to the number of positive particles. They cannot, however, be considered simply as the sum of the forces between the positive particles, as they are additive only in isotopes, that is, when the charge on the nucleus is equal. The simplest assumption, therefore, would appear to be that the nuclei of isotopes differ in their linear dimensions, but not at all, or only very little, in the arrangement of the particles.

F. A. LINDEMANN.

Sidholme, Sidmouth, February 10.

The Green Flash.

PROF. PORTER'S explanation of the green flash (NATURE, February 18) is unable to account for its appearance at sunrise, when it can be observed with great brilliance. When I was passing through the Indian Ocean on my way to observe the total eclipse of 1875 I happened to be on deck before sunrise one morning, and, watching for the first ray of the sun, was surprised to see the first flash of light appear as a vivid green. I had never heard of the phenomenon before, but atmospheric dispersion seemed to me sufficient to account for it, and I took it for granted that it was a well-known occurrence. I continued to observe the same effect several mornings in succession.

Since then I have undertaken many sea journeys, and though I do not recollect having ever again observed the flash or tried to observe it at sunrise, I have never lost an opportunity of watching for it at sunset. My experience does not support Prof. Porter's explanation, because the redder the sun at sunset, the less likely is the green flash to appear. The atmospheric conditions must be such that there is as little absorption as possible of the more refrangible part of the spectrum.

Those who want to see the appearance at its best should keep one eye closed as long as possible, and when the sun is just about to disappear, shut the eye which has been watching the setting sun, and open the other, which is then unaffected by the troublesome after-images which are otherwise seen. It is, of course, impossible to open the eye just at the critical moment, so that this alone is not sufficient to disprove Prof. Porter's explanation.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks., February 21.

Hormones and Heredity.

THE reviewer of Mr. H. Elliot's translation of Lamarck's "Philosophie Zoologique" in NATURE of February 11 remarks: "Unless we have misunderstood, a similar suggestion was made by Mr. J. T. Cunningham in 1908." The word "similar" refers to an alleged suggestion by Prof. MacBride that hormones may afford a clue to a possible *modus operandi* of the transmission of modifications. I should be glad to know when and where Prof. MacBride's suggestion was published, as I have not heard of it before. It would seem from the terms of this review that neither Mr. H. Elliot nor J. A. T. are fully acquainted with my paper on the heredity of secondary sexual characters in relation to hormones, published in the *Archiv für Entwicklungsmechanik* in 1908. The hormone theory of heredity is elaborated in considerable detail in my paper. I do not think it is possible to misunderstand it, and it is much more than a "suggestion."

J. T. CUNNINGHAM.

S.W. Polytechnic, Chelsea, February 15.

IT seemed to me that there was some historical interest in recalling Mr. Cunningham's paper of 1908.

As I was unable at the time to refresh my memory on the subject, I wrote guardedly, "Unless we have misunderstood." A fitter expression would have been, "If we remember aright." It is satisfactory to know that my recollection was substantially correct. To object to the theory being called a "suggestion" seems fastidious. As to Prof. MacBride's suggestion, Mr. Elliot's reference was to a proof of vol. i. of "A Treatise on Embryology."

J. A. T.

THE NATURAL HISTORY BUILDING OF THE UNITED STATES NATIONAL MUSEUM.[1]

MR. RATHBUN has done well to publish a full technical account of this building, which claims "to be greatly in advance of all other museum buildings intended for a similar purpose." The three objects aimed at have been storage, usable exhibition space, and laboratory accommodation. The epithet "usable" is important, for in exhibition galleries dark corners and obtrusive architectural details are worse than useless. "Usable" also implies facility of accommodation to growing and changing needs. With this in view, the building has been planned as a great shell, with few permanent division walls; and, by giving exceptional width to the main mass, the floor area is large in proportion to the extent of outer wall. The plan, which covers nearly four acres, shows a large pavilion surmounted by a rotunda facing south, and from it three wings extending towards the east, west, and north; the latter are connected near their outer ends by two L-shaped ranges, completing the enclosure of two large uncovered courts.

The length of the southern façade, shown in perspective in our Fig. 1, is 561 ft.; the greatest north and south measurement, which is along the middle block, is about 364 ft.; each court is 128 ft. square. The wings have a width of 116 ft.; and the L-shaped ranges a width of 61 ft. This great width and the fact that the building is four storeys high might lead one to expect a deficiency of light. The modern classic style, however, has permitted exceptionally large windows (Fig. 1) in all but the upper storey, where, of course, skylights are available. Moreover, in these windows a maximum of glass surface has been secured by the use of light metal framing. Light is also furnished to the wings by light-wells 50 ft. wide, which break through the upper storeys and light all except the basement or ground storey. The floor of the first storey is thus all available, but the top-lit area is usually separated by glazed

FIG. 1.—United States National Museum, Natural History Building, viewed from S.E., showing the South front, the outer end of the East wing, and the beginning of the East range.

[1] "A Descriptive Account of the Building recently Erected for the Departments of Natural History of the United States National Museum." By Richard Rathbun. U.S. National Museum, Bull. 80. Pp. 132+xxxiv plates. (Washington, 1913.)

screens from the surrounding aisles. Our second figure shows part of an L-shaped range on this floor, with the outer windows on the right, and on the left windows to the open court. The actual interior width is 54 ft. 2 in., and the ceiling height is 20 ft. The severity of the interior is not unpleasing, and for exhibition galleries is better than any ornament.

The general absence of interior structural walls has necessitated the introduction of piers and columns arranged in one or more rows, as shown on the right of our Fig. 2. These, as well as the wall piers, are at a distance of 18 ft. 6 in. from centre to centre. Rooms can be formed in multiples of this unit by the building of partitions between the columns, or to meet varying needs the exhibition galleries can likewise be broken up by slighter screens of material appropriate to each case. As the museum grows and changes there will be no difficulty in making such alterations, for all the mains from the heating and lighting plant run in tunnels under the basement, and are connected with each floor by two vertical chases cut in each wall pier. These chases also serve for electrical communications, ventilating flues, vacuum-cleaning pipes, hot and cold water supply, and the like. Thus for the future we can almost imagine that in this building "neither hammer, nor axe, nor any tool of iron" will be heard in the hands of the workmen, but that the staff will be left to work in peace.

The vacuum-cleaning pipes lead from a single pump in the basement, driven by a 25-h.p. motor, and are connected with seventy-three inlets to which can be attached rubber dust-hose provided with a complete equipment of dusting tools. These will be of particular value in the cleaning of exhibition cases.

The rounds of the night-watch are controlled by a system of recording clocks with paper dials, which mark the signals and transmit them to a central station. Time is indicated by sixteen dials electrically controlled by a master clock and corrected each noon from the Naval Observatory.

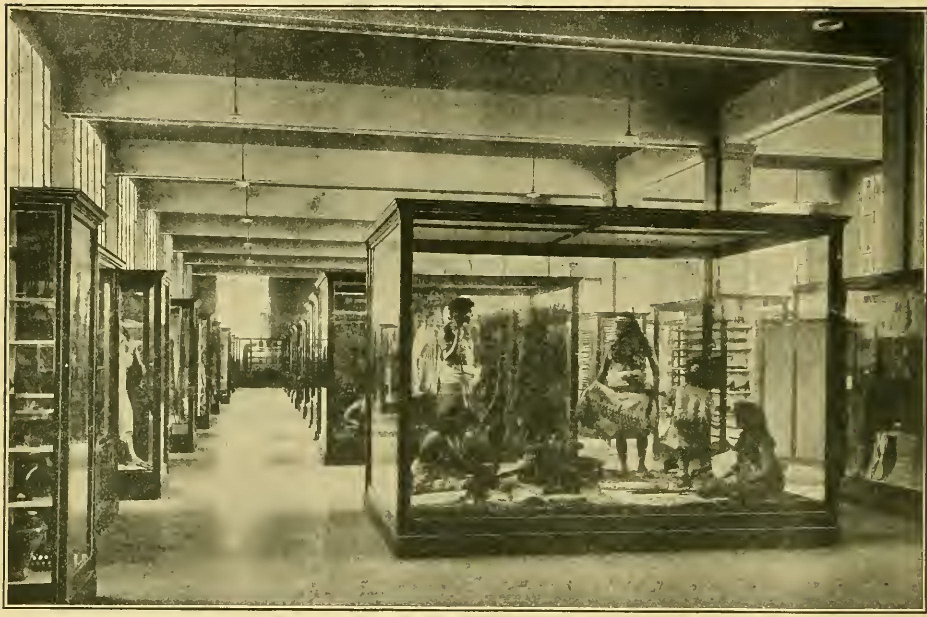

Fig. 2.—United States National Museum, Natural History Building. The Gallery of Ethnology, on the first storey of the East range.

There are six electric Otis elevators, four for passengers and two for freight. The latter are near the large wagon entrances, and run from ground to attic; their cars measure 7 ft. 3 in. by 11 ft. 4 in., by 12 ft. high, and can take a load of 12,000 lb.

Nearly all the ground storey of the east wing is occupied by the machinery plant, which serves the older buildings also. Except for the generator engines, the two stoker engines, and six pumps in the engine-room, which are worked by steam, all motive power is supplied by electricity and is conveyed to the various laboratories and workshops.

The latter consist of painters', cabinet-makers', joiners', and metal-workers' shops, all on the south of this wing. This concentration warrants the use of machinery, and almost every kind of wood-working tool, down to the oil-stone, has its individual electric motor. The "sweat of man's brow" sounds archaic here, but none the less the artisans have a shower-bath and dressing-room. Each department has also its own laboratories, work-rooms, and "comfort-rooms."

The abundant storage space is fitted with standardised shelves, drawers, and cases, permitting ready rearrangement and interchange.

The auditorium is well designed, accessible, and isolated. There are also two rooms for committees and small scientific meetings.

This book does not profess to describe the installation of the exhibits, though a few plates (see Fig. 2) show the general effect. Its value lies in its account of structural detail and practical fitments; it should be read by every museum governor, and digested by every architect of future museum buildings. The claim advanced may not be substantiated at every point, but as regards those here mentioned it is enough to say that the United States Museum possesses what our own Natural History Museum notoriously lacks.

DUTY-FREE ALCOHOL FOR SCIENTIFIC PURPOSES.

In the recent discussions on the best means of developing the colour industry in this country, reference has frequently been made to the duty charged upon pure methyl and ethyl alcohol, which are essential for certain products. Although the past and present stagnation is mainly due to other and much more deep-seated causes, the fact that the trade is still handicapped by a form of taxation which does not exist in Continental countries is one of the signs of the steady indifference of the Government to scientific industrial development of which Thomas Thomson so bitterly complained in his history of chemistry written nearly a century ago.

As the result of a very widespread feeling of dissatisfaction with the high cost of these alcohols (a feeling which had long existed in all the important centres of chemical research in this country) the subject was brought before the chemical section of the British Association at the Glasgow meeting in 1901, and an influential committee was formed, which was successful in persuading the Board of Inland Revenue to forgo the duty on methyl and ethyl alcohol used for scientific purposes in approved institutions. Their recommendations were embodied in the Finance Act of 1902, the working of which has, we believe, given general satisfaction. Whether or not the laboratories of manufacturing firms are permitted to share these advantages we cannot state. Yet in spite of the virtual, if tardy, concession of the principle that research can be usefully promoted in this way, one is constantly confronted with the sort of trivial annoyance such as Sir William Ramsay and Prof. Hickson have recently suffered at the hands of the excise authorities (see NATURE, February 11 and 18), who imposed a duty on the spirit in which specimens coming from abroad were preserved. "Red tape" seems almost too soft a material for binding the cast iron regulations which govern the Excise Department. If, however, the above principle is recognised and conceded, surely it might be adopted in a broad and, if possible, scientific spirit on the part of the authorities. It is not only carried out in the narrowest spirit of officialdom, but also is applied with an extraordinary absence of logic, such as is only conceivable where ignorance of the elements of organic chemistry exists.

For example, chloroform and ether made from ethyl alcohol pay duty, whereas that from methylated spirit (methylated ether) in one case and acetone in the other do not, although the products are practically identical. Again, methyl and ethyl alcohol used for research are exempt from duty, whereas ethyl acetate and butyrate, ethyl chloride, bromide, iodide, and chloral hydrate, in all of which ethyl alcohol is used, are not exempt. The corresponding methyl derivatives which are obtained in precisely the same way from methyl alcohol are not scheduled and, we presume, are free to all consumers. It may be seen from the table of excise regulations that chemists keeping or using stills are subject to a tax of ten shillings on each still, although it should be stated to the credit of the excise department that the payment is rarely if ever enforced in laboratories so far as we know. Perhaps at some future date the regulation may be modified. We see in all this a tardy and grudging response to those pressing demands for liberty of research, which foreign Governments have so successfully encouraged.

But it is not the duty on alcohol which has been the main factor in crippling the colour industry during the last thirty years. Nor is it defective training, equipment, or ability of the young chemists turned out from our universities, whose scientific work stands second to none. It is that the manufacturing world is only beginning to realise at this time of crisis in the chemical industry the true value of the research chemist. We say "beginning to realise," for it was only a few days ago that a professor of chemistry in one of our provincial universities received a request from a large and wealthy corporation to recommend a first-rate chemist, to whom the handsome salary of thirty shillings a week was offered, or about a third of the earnings of a coal-miner working full time!

It would take up too much space to attempt to trace the cause of that attitude of indifference among nearly all classes to the application of scientific research to industry which is such a striking feature of German commercial development. There can be no question that the key to the problem is to be found in our educational system. The very terms "humanities" and "stinks" are fraught with deep significance. They would appear to contrast what is real and living with what is dead and corrupt; what is ennobling with what is contemptible. Yet if a comparison were possible it is the humanities which include the dead languages and literature and the history of dead institutions, whilst the sciences bring us directly into contact with present realities. Nevertheless, it is the former which take precedence in our public schools and our older seats of learning and command the highest marks in Civil Service examinations, whilst chemistry and the other sciences are tolerated though not encouraged, and are valued by the Civil Service commissioners at less than one-third that of the classics and one-quarter that of pure and applied mathematics.

The conclusions are obvious. Our highly-educated Government officials and princes of industry are more or less ignorant of science. It is for many of them an unknown and mysterious region into which they would prefer not to penetrate. That Nemesis now confronts our industries may be a blessing in disguise. It is only in a struggle that the weak points in one's armour are disclosed. We are learning a lesson, which might have been learnt years ago had we not been so inexorably bound by tradition, and the sooner we profit by it the better.

METEOROLOGY AND THE WAR.

In an article which occupies a prominent position in *Le Petit Journal* of February 9, l'Abbé Moreux, the director of Bourges Observatory, emphasises the importance which Germany attaches to meteorological observations and forecasts in connection with the war on land, on sea, and in the air. The fact is scarcely surprising when it is remembered that the great damage done sixty years ago on November 14, 1854, to the allied fleets in the Black Sea by a storm, the course of which could be followed across Europe, was the factor which led Leverrier to conceive and inaugurate the service of international meteorological telegrams. Meteorology is essentially so co-operative and peaceful a science that its stormy birth is apt to be forgotten.

According to M. Moreux, Germany transferred meteorologists from Aix-la-Chapelle to Liège and then to Brussels almost simultaneously with the entry of her army into these cities; and when she found the Aix-la-Chapelle staff not sufficiently expert for her needs she brought up more competent authorities from Berlin and reinforced them with astronomers whose special duty was to watch sounding balloons. The evidence on this point does not appear, however, to be very conclusive, and from the marvellous successes in the prophetic sphere which have been attributed to the German representatives in Belgium it would appear probable that the race of Galeotti, and not that of Galileo, has been invited to render assistance.

Meteorology, along with other departments of science, is bound to have important bearings on the present war. It is, perhaps, more closely associated with the actual active operations than many other departments of science; but its application is not likely to be rendered more successful by substituting for men who are intimately acquainted with the subject men who have achieved distinction in quite a different field; nor by moving the experts from the central institution to the local field of operations. Progress in forecasting in recent years has been achieved by extending the area from which observations are received by telegraph rather than by special observations at a single place; and the meteorological expert's work is to co-ordinate the results of other people's observations, mainly by charting them, rather than to make the observations or to apply the deductions based upon them.

It may be added that in normal times Hamburg is the official centre of the German system of weather-telegraphy and forecasting.

NOTES.

WE announce with much regret the death on Monday, March 1, at seventy-five years of age, of Prof. James Geikie, F.R.S., emeritus professor of geology and mineralogy in the University of Edinburgh.

THE King of the Belgians, and Admiral Lord Fisher of Kilverstone, First Sea Lord of the Admiralty, have been elected honorary members of the Institution of Civil Engineers.

A BRONZE statue of Captain R. F. Scott, erected at Portsmouth Dockyard by the subscriptions of naval officers and officials of the Dockyard, was unveiled on February 26 by Admiral Sir Hedworth Meux, the Commander-in-Chief at Portsmouth. The monument is the work of Lady Scott, and shows Captain Scott in his Antarctic dress.

THE following candidates have been selected by the Council of the Royal Society to be recommended for election into the Society:—Prof. F. W. Andrewes, Prof. A. W. Conway, Mr. L. Doncaster, Mr. J. Evershed, Dr. W. M. Fletcher, Prof. A. G. Green, Mr. H. H. Hayden, Dr. J. Mackenzie, Prof. J. C. McLennan, Dr. A. T. Masterman, Prof. G. T. Morgan, Dr. C. S. Myers, Mr. G. C. Simpson, Mr. A. A. Campbell Swinton, Mr. A. G. Tansley.

WE regret to see the announcement of the death, in his fifty-seventh year, of Mr. Frank T. Bullen, whose knowledge of the sea and its natural history made him distinguished among writers of sea stories. Mr. Bullen was a junior clerk in the Meteorological Office for several years previous to 1899, and while occupying that post he contributed to NATURE of June 4, 1896, a very interesting article on "The Sperm Whale and its Food." This was before he had attained fame by his book, "The Cruise of the Cachalot," but we were impressed at the time by the clear and attractive style of the article, and were glad to know that later Mr. Bullen's real literary gifts received general recognition.

SIR CHARLES A. PARSONS has made a gift of 5000*l.* to the Royal Institution. The following resolution passed by the managers was approved by the members on March 1:—"That the managers of the Royal Institution desire to express to the Hon. Sir Charles A. Parsons, K.C.B., F.R.S.,, who has unconditionally placed at their disposal, for the purposes of the institution, the sum of 5000*l.*, their most grateful appreciation of his munificence and discernment. They accept the gift as a timely and noble recognition of the good public work the institution has done in the past, and is still doing, in the acquisition and diffusion of scientific knowledge, and as an incitement to maintain and extend its usefulness in the unique position which it has for more than a century occupied."

NEWS received from the Russian Arctic voyager Vilkitski now definitely locates him in Taimyr Bay, to the west of Cape Chelyuskin. A wireless message from him has been picked up by Captain Sverdrup, who is laid up further to the south-west on the same inhospitable coast. Vilkitski, having set out in July from Vladivostok to make the passage to European Russia, has thus accomplished about three-fifths of the voyage along the Russian arctic coast. He proposes to send some of his men to Sverdrup, thus relieving the pressure upon his supplies, for he has encountered such heavy ice conditions hitherto that it does not seem certain that he will be able to get on with his ships next summer. The expedition has ample opportunity to add to geographical knowledge (as it has done already) on the coast where it is now imprisoned.

THE appeal for subscriptions to the Sir William White Memorial Fund has resulted in a sum of 3076*l.* 14*s.* 6*d.*, contributed by 455 subscribers. The committee of the fund has decided that the most suitable form which the memorial could take would be the establishment of a research scholarship in naval architecture to be named after Sir William White; and it has been arranged to hand over to the council of the Institution of Naval Architects the greater part of the funds subscribed so that a sum of at least 100*l.* a year shall be available for the scholarship, which will be administered by the council of that institution. In addition, a medallion portrait will be placed in the new building of the Institution of Civil Engineers; and, finally, at the suggestion of Lady White, a donation of one hundred guineas has been made to the Westminster Hospital, where Sir William White passed away.

A REVISED memorandum on cerebro-spinal meningitis, or "spotted fever," has been issued by the Local Government Board in view of cases of the disease which have occurred in various part of the country. It is issued as a purely precautionary measure, and is intended to indicate to medical practitioners, especially village doctors, that the department is watching the outbreak, and that should suspicious cases occur, free bacteriological examination and isolation accommodation will at once be provided. Suspicious cases should be isolated immediately, and any contact cases closely watched. A warning is issued against overcrowding, and as the germs are first located at the back of the throat any person even slightly suspected of having contracted the disease should refrain from kissing anyone else. So far as the general public is concerned, the outbreak may be regarded with indifference. In London it is stated that not more than twenty cases of the disease have been recognised during the last two months.

WE have recorded already the sudden death, on February 13, of Prof. Wesley Mills, emeritus professor of physiology, McGill University, Montreal. From an obituary notice in the issue of the *British Medical Journal* of February 27 we learn that Prof. Mills took the degree of M.D. in McGill University in 1878. He was for several years demonstrator of physiology with Sir William Osler, and studied at University College with Sir J. Burden-Sanderson and Sir E. A. Schäfer. In 1884 he became lecturer in physiology, and in 1886 professor of the subject at McGill University. He organised the teaching of physiology on modern lines, and was the first Canadian teacher of the subject to have a thoroughly up-to-date, well-equipped laboratory. Among his early contributions to physiology were the studies of cardiac innervation. He became much interested in comparative physiology, and the results of a long series of studies are embodied in a work on "The Nature and Development of Animal Intelligence." In 1889 appeared his "Text-book of Animal Physiology," which was modified in the new edition of 1890 to the "Text-book of Comparative Physiology." In 1906 appeared his "Voice Production in Singing and Speaking," a work which brought him much reputation outside of medical circles. After a serious illness in 1910 he retired, and lived in London, devoting himself with energy and enthusiasm to the study of music.

THE Royal Swedish Academy of Science, Stockholm, has recently erected a monument in the Swedish cemetery at Brookwood, Woking, to the memory of Daniel Solander, F.R.S. The memorial consists of an obelisk of unhewn Swedish stone, with the inscription of the name, and dates of birth and death, and that the memorial was erected by the Academy. Daniel Solander was the son of a clergyman in Pite Lappmark, was born in 1733, entered the University of Uppsala as a student in 1750, and left his native country ten years later for London. Here he became employed in the British Museum, in 1764 was elected a Fellow of the Royal Society, and in 1767 made the acquaintance of Banks, who induced Solander to travel with him in that eventful voyage in the *Endeavour* which was Cook's first expedition to the southern seas. On returning from this voyage in 1771, Solander was adopted by Banks as his secretary and librarian, until his death in 1782 from an apoplectic seizure, in the presence of Sir Charles Blagden and the younger Linnæus, dying ten days later. There exist several portraits of Solander; one, a full-length engraving depicting him as "a Simpling Salamander," another of head and bust to left; and, by far the best, a full-length portrait in oil, by John Zoffany, which belongs to the Linnean Society, and was copied for Sir Joseph Hooker's edition of Banks's *Journal*, published in 1896.

The death is announced, on February 20, of Dr. Ed. C. Seaton, consulting medical officer of health to the Surrey County Council. We are indebted to the *British Medical Journal* for the following particulars of his life and work. He studied medicine at St. Thomas's Hospital, and took the degree of M.D. at the University of London in 1871. From 1886 to 1908 he was lecturer on public health at St. Thomas's Hospital, and was at different times examiner in State medicine in the Universities of London, Oxford, and Cambridge, and at the Royal Colleges of Physicians and Surgeons of London. He was the author of the article on vaccination in Quain's "Dictionary of Medicine." He delivered the address in public medicine at the annual meeting of the British Medical Association in 1891, taking as his subject the evolution of sanitary administration in England. He read a communication on diphtheria before the International Congress of Medicine at Budapest in 1894, and delivered the Milroy Lectures at the Royal College of Physicians in 1896. His Chadwick Lectures at the University of London on "Infectious Diseases and their Preventive Treatment," published in 1910, may be taken as containing a summary of his matured views on subjects to the study of which he had given his professional life. Dr. Seaton took an active part in promoting legislation for the compulsory notification of infectious diseases, and was the author of numerous reports and papers on the subject. He was a Fellow of the Royal Sanitary Institute and a member of the Society of Public Analysts. For more than forty years he was a member of the British Medical Association.

Shortly after the commencement of the war, the British Science Guild referred to two of its committees the question of the supply of laboratory and optical glasses, most of which had been obtained from Germany and Austria. The reports of these committees have now been completed, and will be issued shortly. The Institute of Chemistry took up the subject about the same time, and appointed a Glass Research Committee, the main purpose of which was to determine, by experiment, the constitution of glasses suitable for various purposes and to communicate the formulæ to manufacturers. The research has been carried on at King's College, London, and formulæ have been arrived at for an alumina-soda glass suitable for the manufacture of chemical laboratory ware and for a glass which is a satisfactory substitute for Jena glass in respect of its resistance to water and reagents. Provided with these and other formulæ, the only question left for manufacturers contemplating the laying down of plant for the production of laboratory glass to consider was the prospect of the industry after the war. In order to obtain information upon this point, the British Science Guild, acting jointly with the Association of Public School Science Masters, sent a circular letter to local education committees throughout England, councils of universities and technical institutions, and governors of the chief secondary schools, including all the public schools represented on the Headmasters' Conference. The result of the inquiry has been most satisfactory. In general it may be said that about three-quarters of the bodies concerned have undertaken to use British-made laboratory glass during the war, and for a period of three years after, provided that the price is not prohibitive. Two scientific organisations, on their own initiative and without any assistance, financial or otherwise, from the Government, have thus been able to do most valuable work for British glass manufacture. It is to be hoped that official recognition will be given to the service they have rendered to national welfare.

The question of the origin of culture, through direct transmission by migration or trade from a single centre, or by independent evolution in more than one area, is in the air at present. A useful contribution to the controversy is provided by Mr. Eldson Best in the January issue of *Man*. One of the most beautiful of the several types of greenstone pendants made by the Neolithic Maori is that called the Tautau. The existence of this type has been, at various times, advanced as proof of American and Asiatic relationships in Maori art, and Mr. Hamilton, the best authority on the subject, states that this form is as yet unexplained. Mr. Best now brings forward evidence to show that this type is indigenous and not genetically related to objects of similar shape found in other parts of the world. He traces its origin to a form of fish-hook consisting of a bone barb, sometimes beautifully carved, fitted into a hole which passes through the lower end of a straight wooden shaft. A series of illustrations indicates the phases through which the ornament was gradually developed from this form of fish-hook.

Mr. A. S. F. Gow contributes to the *Journal of Hellenic Studies*, vol. xxxiv., part 2, a valuable paper on the evolution of the plough of Greek and Roman days. It starts with those ploughs in which the main timbers are of one piece. Then follows the plough which has stock and pole in one piece, but the tail inserted artificially. The next step in complexity is when all the three main members are separate timbers artificially joined. Fourthly, comes the variety in which pole and tail rise together from the hinder part of the stock, stock and pole have lost the exaggerated solidity seen in the earlier examples, and the pole, not the stock, is now the most important member in the implement. The accounts of the plough in Virgil and Hesiod are carefully discussed, with other classical references, and the paper is illustrated with a good series of photographs from the monuments and of modern Greek and Italian ploughs. The writer does not seem to be acquainted with the important article by Sir E. Tylor, "On the Origin of the Plough and Wheel-Carriage," in vol. x. of the Journal of the Anthropological Institute (1881).

We have received from Mr. E. J. Brill, of Leyden, a catalogue of books and pamphlets dealing with the geology, botany, zoology, etc., of the Dutch East Indies, together with others relating to tropical diseases and medicine and climatology.

At the monthly general meeting of the Zoological Society, held on February 17, it was stated in the report of the council that thirty additions had been made to the menagerie during January, of which twenty-two were acquired by presentation, one by purchase, and two by exchange, while three were received on deposit, and two were born in the gardens. Amongst these was a sing-sing waterbuck, a squirrel-monkey, a kinkajou, two Senegal genets, and a spotted fire-finch (*Lagonosticta niveiguttata*), the last a species new to the collection.

IN the reports on the Hunterian Collections in the University of Glasgow for 1913–14 it is stated that, in addition to a considerable number previously identified, many type-specimens of insects described by Fabricius have been recognised recently, as well as a number of the specimens figured in Drury's "Illustrations of Natural History," and Olivier's "Entomologie," 1789–1808. These the curator hopes may eventually be housed in a fireproof building. All the collections are reported to be in good condition; and in some instances have received considerable augmentation during the period under review.

NEXT time the editor of *My Children's Magazine* requires a picture of a whale he would be well advised to send his artist to the Natural History Museum instead of allowing him to evolve from his own mind the grotesque caricature of a sperm-whale (with upper teeth!) which forms the frontispiece to the March issue of that journal. The picture is intended to represent a whale stranded at Greenwich in the time of John Evelyn, by whom it was seen and measured. There is no proof that this was a sperm-whale, and it was much more probably a common rorqual (as is suggested by Evelyn's mention of a "picked snout"), a species of which, a female, was stranded some twenty years ago at Woolwich, where it gave birth to a couple of young. Another error in the same issue is the statement that the wool used in the manufacture of "cashmere" is the product of *wild* goats.

MR. C. F. JURITZ contributes a paper on plant poisons of South African plants in vol. xi., No. 4, of the *South African Journal of Science*, which is of value in pointing out the pharmacological possibilities of the rich native flora. Interesting particulars are given of the toxic properties of the fruits of the Cycad, Encephalartos, various Liliaceæ, and Amaryllidaceæ, which are so numerous at the Cape, and of many other plants under their respective natural orders.

THE pocket-book for 1915 issued by the Royal Botanic Society of London is a mine of miscellaneous and very useful information, giving not only the various horticultural fixtures for the year, but also such things as the different weights and measures and their conversion from one system to another, physical constants, chemical constituents of gems, the composition of soils, manures and their uses for different kinds of trees and plants, and so on. Several pages are devoted to lists of economic plants with their botanical names, natural orders, and uses, which form a very handy source of reference. At the end there is a plan of a tennis-court and croquet-lawn, but the Badminton court, which might have found a place, is not included.

JAPANESE primulas form the subject of an illustrated article by Mr. Takeda in No. xxxviii., vol. viii., of Notes from the Royal Botanic Garden, Edinburgh. Though China is the home *par excellence* of the genus, Japan, according to the present paper, possesses eleven native species. Of these *P. Sieboldii* and *P. japonica* are the best known. Hybridisation, which is uncommon, as a rule, in the genus, is common among the Japanese species, and *P. Sieboldii* is conspicuous as a parent of many hybrids. In the same number of the Notes fifty new Chinese plants are described, collected by G. Forrest or F. K. Ward in West China at altitudes of from 12,000 to 16,000 ft. *Draba alpina*, var. *involucrata*, from the Lichiang range at 15,000 to 16,000 ft., has been grown at the Edinburgh Botanic Garden. Other high-altitude plants are the gentians and saxifrages collected by F. K. Ward on the borders of Yunnan and Tibet up to 16,000 ft.

THE Hawaiian Volcano Research Association is a society founded in 1909 and supported by voluntary contributions. Its objects are to record volcanic outbursts and earthquakes in the Hawaiian Islands, and to offer opportunities to scientific men to pursue special studies in connection with volcanic action. The association possesses a volcano observatory near the edge of the crater of Kilauea, and a seismological station at a short distance which is furnished with two Bosch-Omori tromometers, an Omori tromometer, and an Omori seismograph. Weekly bulletins are issued in which the continual changes within the craters are described and lists are given of the numerous earthquakes recorded. An appeal for funds has recently been issued by the board of directors, partly for scientific objects, partly for the construction of stone refuge houses along the north-east rift line of Mauna Loa, as it is almost certain that an outflow of lava will shortly take place along that line.

ATTENTION has been directed on more than one occasion in these columns to the need of journals publishing summaries of current mathematical work in the form of lists of new books and of the contents of periodicals. This has been a feature of the Bulletin of the Calcutta Mathematical Society, which, however, has up till now reached us considerably out of date. The Tôhoku Mathematical Journal (vol. vi.), published in Sendai, Japan, now publishes these lists, and although some of the printed matter is scarcely likely to be intelligible to the majority of English readers, the titles of many papers are at any rate printed in the language of publication, and the references are to recent work.

IN his "Notes on Some Focometric Apparatus" in the December, 1914, number of the Journal of the Royal Microscopical Society, Mr. F. J. Cheshire states that he has found the following modification of Blakesley's arrangement for determining the focal length of a short-focus system by the method of magnification, most convenient for the ordinary requirements of the microscopist. An achromatic system of focal length 2·6 cm. is mounted in the middle of a tube having a millimetre scale at its lower and a slit a millimetre wide at its upper end, the slit and scale being at the foci of the system. The tube is fitted under the stage of a microscope with the slit in the plane of the stage. The eyepiece of the microscope is provided with a graduated scale, and on focussing the lower scale, the number of eyepiece divisions corresponding to a lower scale divisions is read. The system the focal length of which is to be determined is then introduced between the objective and the slit, the microscope again focussed, and the number of eyepiece divisions covered by a division of the lower scale again read. The quotient of the two readings gives the focal length of the system. By a proper choice of scales the focal length may obviously be read at one operation in any desired unit.

THE Bureau of Standards, Washington, U.S.A., has issued a circular (No. 51) describing the method adopted for testing watches and timepieces, and detailing the conditions under which the bureau is prepared to issue certificates showing the quality of the performance. The tests naturally do not differ greatly from those that experience has proved to be practical and satisfactory in other observatories and institutions, where regular tests are carried on. An omission of some importance, as it seems to us, is the failure to mention the connection between this testing department and any observatory of repute. No information is provided as to the manner in which the time determinations are made, or how the errors of the mean time clock are eliminated. The bureau may be in connection with the U.S. Naval Observatory at Washington, and the authorities in charge of that observatory may be responsible for the accuracy of the time record. More distinctness on this head would have been welcome, as in the last report from the Naval Observatory it was stated that an insufficient number of chronometers and watches were submitted for trial, and that every effort was being made to induce makers to submit instruments for test. Some useful information is provided concerning the care and treatment of accurate timekeepers, and a table is given showing the main centres on railways, etc., where the change of time is made in passing critical meridians. Where so many abrupt changes occur between the Atlantic and Pacific coasts, this table should prove valuable.

IN No. 1, vol. iv., of the Memoirs of the Department of Agriculture in India, Harrison and Subramania continue the account of their work on the gases of swamp rice soils. In the first paper on this subject it was suggested that the gases formed in the soil had an important connection with the aeration of the roots of the crop. This theory is now elaborated, and a detailed investigation is made of the mechanism by which the organised film, in contact with the surface of these swamp soils, utilises the soil gases for the production of oxygen. It is shown by experiment that the film can oxidise both methane and hydrogen, and, further, that the resulting carbon dioxide is decomposed, with evolution of oxygen, by the green algæ and diatoms which are always present in the film. Crude cultures of bacteria have been prepared capable of bringing about the first of these changes, but no specific organism was isolated having the power to oxidise either methane or hydrogen in pure culture. A mixed culture of two organisms, however, is stated to oxidise hydrogen to water in the presence of very small amounts of nitrogenous organic matter. The film may be looked upon as fulfilling the duty of an oxygen concentrator at a point which enables the maximum oxygen concentration to be produced in the water entering the soil. The practice of green manuring increases the production of soil gases, which is otherwise comparatively small, leading to an increased oxygen output by the surface film and better root aeration. Hence there is deeper root development resulting in sturdier and more productive plants. A further paper dealing mainly with the bacteriological side of the investigation is to be published shortly.

THE Isthmian Canal Commissioners decided some time ago that the requirements of the Panama Canal necessitated the provision of two large floating cranes capable of handling such heavy loads as the largest lock- and dock-gate leaves. Tenders were asked for two floating cranes, each of 250 tons capacity, and the contract was awarded to the Deutsche Maschinen Fabrik A.-G., of Duisburg, because "the proposal of the German firm was so much lower in price than any other, and the experience, facilities, and reputation of this firm so excellent, that it was unquestionably the best of those received." The quotation is from the official records, and *Engineering* for February 26 aptly puts the question as to whether this opinion is still held in view of what happened to the first of the cranes when undergoing its test loading. The load was not quite out to the specified distance when the jib collapsed. Our contemporary publishes photographs of the crane after the accident, from which it appears that the jib was insufficiently braced, and that the accident might have been avoided by the presence of a few additional members. The damage is estimated at about 120,000 dollars, and the work will take about six months to put right.

THE *Engineer* for February 26 gives an illustrated description of an enormous locomotive built for the Erie Railroad by the Baldwin Locomotive Works of Philadelphia. The engine is of the 2–8–8–8–2 type in wheel arrangement, and has six cylinders; two of the cylinders are high-pressure, and each of these exhausts into two low-pressure cylinders. All the cylinders are of the same size, viz., 36 in. diameter and 32 in. stroke. The wheel base is 90 ft. in length, and 89 per cent. of the weight of the engine and tender is carried on the driving wheels. The boiler is 8 ft. diameter at the smoke-box and 9 ft. diameter at the dome. A Schmidt superheater having 1584 sq. ft. of surface is fitted, and is said to be the largest yet made for a locomotive. The total weight of the engine and tender is 380 tons (long). The engine will do duty as a banking engine on a long gradient of 1 in 95, where at present the standard goods train, hauled by a 2–8–0 engine, requires two 2–8–0 engines and a Mallet engine as combined banking engines. The new engine will do the work of the three present engines on the bank. It will be coupled into the middle of the train, thus reducing the stresses on the couplings and drawbars and avoiding any tendency to buckle the train in the middle due to excessive pushing forces in the rear.

THE forthcoming books of Messrs. John Wiley and Sons, Inc. (New York), include: Elementary Chemical Microscopy, E. M. Chamot; The Examination of Hydrocarbon Oils and of Saponifiable Fats, D. Holde, translated by E. Mueller; Text-Book of Geology, L. V. Pirsson and C. Schuchert; A Meteorological Treatise on the Circulation and Radiation in the Atmospheres of the Earth and of the Sun, F. H. Bigelow; Manual for Health Officers, J. S. MacNutt; Constant-Voltage Transmission, H. B. Dwight; Field Book of Railroad Engineering, W. G. Raymond; Materials of Construction: their Manufacture, Properties and Uses, A. P. Mills; Steam Power, C. F. Hirshfeld and T. C. Ulbricht; The Railroad Taper: the Theory and Application of a Compound Transition Curve based upon 30-foot Chords, L. Perkins; Working Data for Irrigation Engineers, E. A. Moritz; A Shop Mathematics for Machinists, R. W. Burnham; Interpolated Six-Place Tables, H. W. Marsh; Masonry, M. A. Howe; Plain and Reinforced Concrete Arches, J. Melan, translated by D. B. Steinman.

OUR ASTRONOMICAL COLUMN.

THE RETURN OF METCALF'S COMET?—In NATURE of February 25 reference was made to a telegram received by Prof. Strömgren relative to the discovery of an object by Miss Leavitt believed to be Metcalf's comet. The *Morning Post* of February 23 published the following paragraph relative to this discovery: "A telegram from Prof. Pickering has just been received stating that the object reported as Comet Metcalf turns out to be a minor planet. This must be a disappointment to Miss Leavitt, but it accounts for the failure of astronomers to find the comet when better placed. The question of priority of discovery, as evidenced by the Southern comet of last year, which was discovered independently at Johannesburg, Arequipa, and Christchurch, New Zealand, on the very same day, has been already responsible for premature publication. Prof. Pickering is, however, generally prepared to take the risk and is sometimes fully justified."

THE CANADIAN 72-INCH REFLECTING TELESCOPE.—Dr. J. S. Plaskett communicates some very satisfactory information about the large Canadian mirror which is in process of being worked up. (Journal of the Royal Astronomical Society of Canada, Nov.–Dec., 1914.) The mirror is actually $73\frac{3}{8}$ inches in diameter and $13\frac{3}{8}$ inches thick, weighing 4962 pounds, or a little more than two tons. An excellent idea of the size of this vast piece of glass will be gathered from the illustration accompanying Dr. Plaskett's note, showing the disc with Dr. John Brashear sitting beside it. Already the edge has been ground, the labour occupying three weeks, and the more delicate and dangerous work of drilling the central hole has been satisfactorily completed. The latter involved first boring a hole of 9 inches diameter, then enlarging it to 10 inches, and finally smoothing and squaring it up and bevelling off the top edge. The next procedure is the figuring of the upper and lower surfaces to make each plane in order to choose which surface is the more suitable for shaping into parabolic form. It is satisfactory to read that "the more the disc is examined the better it seems to be, and hopes are high that it will prove a great success."

ANOMALOUS DISPERSION IN THE SUN.—No. 93 of the Contributions from the Mount Wilson Observatory contains a communication from Mr. Charles E. St. John, entitled "Anomalous Dispersion in the Sun in the Light of Observations." Mr. St. John first directs attention to recent publications by Prof. Julius, who has considered the displacements of the Fraunhofer lines at the centre and limb edges of eccentrically located sun-spots from the point of view of his theory of anomalous dispersion. In these Prof. Julius has set forth "a new deduction from the theory of anomalous dispersion—the "mutual influence" of the Fraunhofer lines upon each other; in particular, that a weak line on the violet side of, and near to, a stronger line is displaced less, but if on the red side more, than the average amount." The above deduction affords Mr. St. John, as he says, an opportunity of making a quantitative test of the rôle played by anomalous dispersion in the solar atmosphere, and this he does in the present paper. It may be remarked that Prof. Julius used the data published by Mr. St. John in his paper, "Radial Motion in Sun-spots." In the present discussion, which covers more than forty pages, it is impossible to refer even briefly to any of the details here stated. Mr. St. John sums up in eleven paragraphs the results of his investigation, and the reader must refer to the article itself for further information. The general result may, however, be expressed by reproducing the last paragraph of the summary. "The general conclusion from this review of solar observations is that the deductions from the anomalous dispersion theory which are susceptible of definite and quantitative tests are not supported by the observational data, and that observations are outstanding which have not yet been explained by the theory."

GREAT DETONATING FIREBALL IN SOUTH AFRICA.—Some of the South African newspapers just received give particulars of a fireball which appeared nearly over Cradock and Queenstown on January 9 last at 1.20 a.m. It vividly illuminated the heavens for several seconds, and was followed shortly after by a series of loud explosions.

The meteor evidently came from the N.N.W., passing between Cradock and Queenstown, and finally disappearing to the S.E. of the former place at a distance of about 24 miles, but the exact figures are doubtful. The estimated interval between the flash and the detonation was variously given by different persons at Cradock between 30 seconds and 3 minutes. The meteor may have fallen to the earth in the region S.E. of Cradock, and it is to be hoped that a thorough search has been instituted for the object. Its flight appears to have been directed from the position of the radiant of the January meteoric shower from Quadrans, the maximum display from which is usually developed on January 3. But the shower is certainly prolonged until January 9. The meteor, however, more probably owed its origin to a radiant in the constellation Draco.

The recent meteor startled a large number of persons by its loud detonation. Houses are said to have been shaken, and the visitation was ascribed by many people to an earthquake. The real path cannot be satisfactorily computed from the observations, which are not of a suitably exact character. The period from January 9 to 14 is notably rich in fireballs, and it merits further investigation. There are evidently a number of radiant points active at this epoch, and among those best pronounced will be found positions at $120°+0°$, $148°-12°$, $230°+52°$, and $332°+36°$.

PROFESSIONAL CHEMISTS AND THE WAR.[1]

It is a matter of importance to the representatives of the chemical profession that their aspect of the great coal-tar colour industry should be kept well to the fore in the Government scheme and in any other scheme that may hereafter be put forward. We desire to see the restoration of the industry to this country, and not only restored, but also permanently retained after the war. The discussions of the Government schemes in various parts of the country by dye-consuming organisations, chambers of commerce, and so forth, have all centred round political or economic questions; the vital principle, viz., adequate chemical control, has been subordinated or left out of consideration altogether. While there has been much wrangling over the question as to the method by which the industry may be established and maintained here, whether by free trade or protection, or subvention, or by any other device, the consideration of the questions whether a few years hence there will be anything in the way of dyestuffs worth protecting; whether there will be a sufficient basis of material products left for the politicians and economists and business people to wrangle over has been overlooked. It is not a purely business problem which the Government has undertaken to solve; it is primarily a chemical problem.

The conditions which have to be met if this country is to be once more the home of the colour industry are imperfectly understood by the public. Even those most concerned—those who are invited to subscribe to the capital—appear in most cases to have an idea that all that is necessary is to find the money, secure Government aid, appoint a board of business directors, and lo! the industry will forthwith spring into existence ready to cope with all emergencies. What are the facts of the case? About five hundred different dyestuffs of definite composition have been given to tinctorial industry as the products of chemical research. Of these a certain number only can be, and are being, made in this country. The total output of our factories is, at present, inadequate for the requirements of our textile industries. The first step to be taken, therefore, is to enlarge and develop existing factories so that the dyes which can be made here may be turned out in larger quantities. This necessity has been provided for in the Government scheme, and "so far so good." If the extension of the existing factories still produces insufficient supplies, new factories must be erected and equipped. That also is provided for in the scheme; but if we want to establish the industry here permanently we must look beyond all this. Where shall we be left after the war? We shall be in possession of processes for making a certain number of dyes, and the supply of their products may possibly be sufficient for the particular purposes for which they are required. But there will still be an outstanding number of other products which have never yet been made here, and for the working out of these processes no combination of "business" talent is of the slightest value. It is not a business question, but a chemical question, and it is by chemical research alone that our colour industry will be saved. The German colour industry has been built up by the utilisation of the results of research carried on in the factories and universities and technical schools for a period of more than forty years! To suppose that we can retrieve our position by starting a company the directorate of which was to consist solely of business people is ludicrous.

One feature of the new scheme which the chemical profession can view with favour is the distinct recognition of research as a necessity for the development of the industry. The Government "will, for ten years, grant not more than 100,000*l.* for experimental and laboratory work." That is certainly a concession which marks an advance in official opinion. It will be for the satirist of the future to point out that it required a European war of unparalleled magnitude to bring about this official recognition of the bearing of science upon industry. Who is to direct this research? A directorate of purely business people will certainly be incompetent; a board composed of dye users can do no more than indicate what dyestuffs were needed. True, it is proposed that the company should take powers to secure the assistance of a committee of experts, but this appears to be simply a reversion to the policy of "drift." The experts are, as usual in this country, to be subordinated and their assistance is to be invoked at the discretion of a board the members of which can have no real knowledge of the conditions necessary for producing the materials they require. Will they be competent to point out dangers ahead? The "staple products" upon which they are asked to stake their capital may a few years hence be superseded by the products of later discovery. The policy of attempting to run a highly specialised and rapidly developing branch of organic chemical industry by a company of business people with expert assistance when required is fatal if it is intended to establish the industry permanently here. The group of industries which has arisen from the products of the tar still is not going to remain stagnant after the war, and it is scientific guidance and not mere assistance that will keep them alive. It is the expert, and the expert only, who can foresee the course of development, who can keep in touch with the progress of research, and direct with intelligence the campaign against competitors. If such scientific direction is withheld, all schemes are sooner or later bound to end in failure.

To other branches of manufacture in which our dependence upon foreign products has been forcibly revealed by the war, professional chemists have been able to render considerable service. It has long been known that laboratory glass and porcelain apparatus and filter paper have been mainly supplied from abroad, and that large quantities of pure chemical reagents and of the special chemicals required for analytical or research work have borne non-British labels. This state of affairs called for prompt action, and the councils of the Institute of Chemistry and the Society of Public Analysts have acted conjointly as a committee for dealing with this matter of such vital importance to the profession. The inquiries instituted by this committee soon brought the fact that failure in the supply of laboratory glass apparatus would not only cripple the work of the chemists, but would also influence to a serious extent certain important industries the dependence of which upon supplies of suitable glass had not at first been foreseen. In connection with these inquiries, it was at a later period considered necessary, in view of the great national interests involved, that the institute should take part in giving practical aid to would-be manufacturers. For this purpose a Glass Research Committee was appointed, and is still carrying on its work. Formulas supplied by members of the committee have been made in the laboratory of the institute and submitted to the recognised tests. The experiments have perforce been carried out on a small scale, but the co-operation of a number of glass manufacturers has been secured, and the results will be tested on a fairly large scale under complete expert control. Not the least important of the glass problems is the production of a suitable glass for miners' safety-lamps, the necessary protecting

[1] From the presidential address delivered to the Institute of Chemistry on March 1, by Prof. Raphael Meldola, F.R.S.

shades for which have also been hitherto mainly imported from abroad. This particular kind of glass is of pressing importance in relation to coal-mining, and it is certainly humiliating to learn from the makers of these lamps that for glass of the required quality capable of complying with the Home Office tests, we have been so largely dependent upon foreign glass manufacturers.

With respect to the supplies of chemical reagents, the joint committee found it necessary to entrust to a special sub-committee the somewhat arduous task of compiling a list of all the commonly used reagents with indications of the standard of purity required and the tests necessary for ascertaining whether the required standard had been reached. The list has been published as a pamphlet, and has been sent to many firms and companies of manufacturing chemists with the view of ascertaining which reagents of their own manufacture they are prepared to supply. When the replies have been received the joint committee will know the requirements of the profession could be met by British manufacturers.

It is hoped that sooner or later laboratory supplies both of apparatus and materials will be entirely of British origin. The manufacturers are—in some cases at considerable cost—developing lines of industry which are of the nature of new departures for this country. It is the duty of consumers and users—in fact, of every branch of the profession—to do their utmost to encourage and support these new home industries. Patriotism and the credit of our country alike demand that, after the war, they should help those who are helping them by insisting upon having nothing but the products of British manufacture. They should not only assist in the development of these industries now, but insure their permanent retention after the declaration of peace. With the achievement of this result there would be removed the reproach that the nation which gave to chemical science Priestley, Black, Boyle, Cavendish, Davy, Dalton, Faraday, and Graham—the country which founded the coal-tar colour industry, and which had taken the lead in the manufacture of "heavy chemicals," allowed her laboratory work to be dependent upon foreign materials, and her great textile and metallurgical industries to be threatened through the stoppage of supplies from inimical countries.

LORD KELVIN'S WORK ON GYROSTATICS.[8]

V. *Gyrostatic Theory of Elasticity.*

[*Note.*—In the explanation of steady precession, near the foot of the first column of p. 715 of NATURE of February 25, the words, "the horizontal axis A of the couple," referred to a cut, which, owing to an accident, could not be given. But Fig. 6 there printed, and repeated here on page 21 will serve instead. In that, as indicated in the small diagram at the bottom of the figure, the axis of angular momentum—the spin-axis—is to be supposed drawn towards the right, from the centre of the gyrostat along the (horizontal) axis of rotation, and the axis of the couple horizontally from the centre towards the observer. The dotted arc, marked 90°, should be continued round to the axis marked $mk^2\omega$. The angle 90° is that between the spin-axis and the couple-axis.—A.G.]

ONE other experiment I shall make with the veteran gyrostat, which has been spun again. You see that the rim carries two trunnions in line with the centre of the wheel (Fig. 10). These are placed on bearings attached to this square wooden frame; and now you see that as I hold the tray in my hands in a horizontal position, the gyrostat rests with its axis vertical or nearly so. The direction in which the wheel is spinning is shown by the arrow on the upper side. I now carry the tray round in azimuth in the direction of spin: nothing happens; the gyrostat spins on placidly. If, however, I carry the tray slowly round the other way, the gyrostat immediately turns upside down on the trunnions; and now, as I go on carrying the tray round in the same direction as before, the gyrostat is quiescent as at first; but the spin, by the inversion of the gyrostat, has been brought into the same direction as the azimuthal motion.

The gyrostat behaves as if it possessed volition—a very decided will of its own. It cannot bear to be carried round in the direction opposed to the rotation, and, as it cannot help the carrying round, it accommodates itself to circumstances by inverting itself so that the two turning motions are made to agree in direction. Again I reverse the azimuthal motion, and the gyrostat inverts itself so that the wheel turns in the same direction in space as at first.

The inversion brings into play a wrench on the hands of the experimenter. A varying couple, lasting during the time of the inversion, is required to reverse the angular momentum of the wheel in space, and this is applied to the gyrostat by the frame at the trunnions, and to the frame, because that is kept steady, by the hands of the operator. The total change of angular momentum is 2 N, where N is the angular momentum of the flywheel, and this is the time-integral of the couple.

It will be noticed that in this experiment, in which the gyrostat displays this curious one-sided stability and instability, it is affected by a precession impressed upon it from without. The system was not

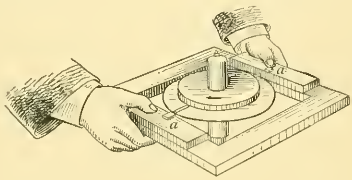

FIG. 10.

left to itself, I carried it round. The gyrostat had little or no gravitational stability—the centre of gravity was nearly on a level with the trunnions; but even if it were gravitationally unstable, sufficiently rapid azimuthal motion would keep it upright if that motion agreed with the spin, while the least motion the other way round would cause it to capsize.

It is important to notice that if the gyrostat be placed on the trunnions, so that the axis of the wheel is in the plane of the frame, azimuthal turning in one direction causes one end of the axis to rise, or turning in the other direction causes the other end to rise. As I shall show presently, this means a reaction couple on the frame which must be balanced by a couple applied by the experimenter.

Better than anything else I know, this experiment of the capsizing of the gyrostat by azimuthal motion affords an example of the two forms of solution of a certain differential equation, which, when the gyrostat is without sensible gravitational stability, and θ is small, I may write

$$A\frac{d^2\theta}{dt^2} + \omega N\theta = 0,$$

where N is the angular momentum of the wheel, and ω the angular speed with which the tray was carried round. When the turnings were in the same direction, ω and N had the same sign, but when the turnings were in opposite directions the product ω N had a negative value. When the product is positive

[8] Abridged from the Sixth Kelvin Lecture, delivered at the Institution of Electrical Engineers, on January 28, by Prof. A. Gray, F.R.S. (Continued from NATURE, No. 2365, vol. xciv., p. 716.)

we have a solution giving oscillations about the vertical, in the period $2\pi\sqrt{A/\omega N}$: the equilibrium is stable. When, however, ω is reversed the product must be given the opposite sign, and we get a solution in real exponentials, starting falling-away from the upright position, which is continued until the opposite (stable) position is attained. N has now also been reversed in space, and the product ωN in the differential equation is again positive.

As I have already stated, the time integral of the turning motive about the vertical required by the gyrostat from the frame constraining it to move round in azimuth is $2N$; that is, $2Cn$, where C is the moment of inertia of the flywheel about its axis. There is thus at each instant of the turning in azimuth before the inversion has been completed a couple required from the frame, and this couple is greater the greater the angular speed n of spin.

The couple arises thus. Let the gyrostat axis have been displaced from the vertical through an angle θ about the trunnion axis. In consequence of the azimuthal motion, at rate ω, say, the outer extremity of the axis of angular momentum is being moved parallel to the instantaneous position of the line of trunnions, and thus there is rate of production R of angular momentum about that line; but there being no applied couple about the trunnions, the gyrostat must begin to turn about the trunnions to neutralise R. This turning tends to erect or to capsize the gyrostat according as the spin and azimuthal motions agree or are opposed in direction. In its turn, however, this involves production of angular momentum about the vertical for which a couple must be applied by the frame, and of course to the frame by the operator. This couple is greater the greater Cn, and therefore if the operator cannot apply so great a couple, an azimuthal turning at rate ω cannot take place. With sufficiently great angular momentum the resistance to azimuthal turning could be made for any stated values of θ and ω greater than any specified amount.

The magnitude of this couple which measures the resistance to turning at a given rate is greatest when the angle θ is 90°; that is, when the axis of the flywheel is in the plane of the frame.

Now I come to an interesting application of these ideas. You are aware that Lord Kelvin endeavoured to frame something like a kinetic theory of elasticity—that is, he conceived the idea that, for example, the rigidity of bodies, their elasticity of shape, depends on motions of the parts of the bodies, hidden from our ordinary senses, as the flywheel of a gyrostat is hidden from our sight and touch by the case. Look at this diagram of a web (Fig. 11). It represents two sets of squares, one shown by full, the other by fine, lines; the former are supposed to be rigid squares, the latter flexible. Unlike ordinary fabrics, which are almost unstretchable except in a direction at 45° to the warp and woof, this web is equally stretchable in all directions. If the web is strained slightly by a small change of each flexible square into a rhombus, or into a not-square rectangle, the areas are to the first order of small quantities unaltered.

Now imagine that a gyrostat is mounted in each of the rigid squares, so that the axis of the trunnions and the axis of rotation are in the plane of the square as shown in Fig. 12. If the angular speeds of the flywheels are sufficiently great, it is impossible to turn the squares in azimuth at any given small angular speed. Thus any strain involving turning of the small squares is resisted, and we have azimuthal rigidity conferred on the web by the gyrostats. There is, however, no resistance to non-rotational displacement of the squares as wholes.

To get a model in three dimensions Lord Kelvin imagined an analogous structure made up of cubes, each composed of a rigid framework to play the part of the squares, and connected by flexible cords joining adjacent corners of the cubes. In each cube he supposed mounted three gyrostats with their trunnions at right angles to the three pairs of sides. This arrangement would, like the web of squares, resist

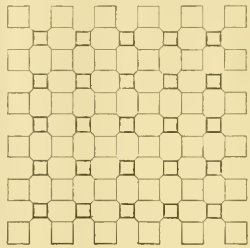

Fig. 11.

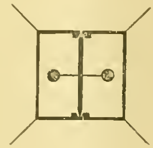

Fig. 12

rotation, but now about any axis whatever; and there would be no resistance to mere translation of the cubes as wholes. Thus the body so constituted would be undistinguishable from an ordinary elastic solid as regards translatory motion, but would resist turning.

It is convenient in this connection to refer to an arrangement—a gyrostatic imitation of a spiral spring—in which a constant displacement is produced and maintained by the action of a constant force in a fixed direction, involving the application of a couple of constant moment, though not of constant direction of axis. This gyrostatic spring balance is indicated in a paper entitled "On a Gyrostatic Adynamic Constitution for Ether," published partly in the *Comptes rendus*,[9] and partly in the Proceedings of the Royal Society of Edinburgh.[10] This is one of the many papers which Lord Kelvin published in the latter part of his life on a question that occupied him much from time to time, the nature of the æther as a vehicle of light and as the medium in which electric and magnetic phenomena are manifested.

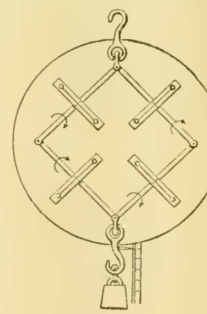

Fig. 13.

The spring balance is described in some detail in his "Popular Lectures and Addresses."[11] I had thought of realising the arrangement, which is shown in Fig. 13, but on consideration I found that though it would act as a spring, it would not, except under certain conditions, not easily realisable even approximately, possess the peculiar property of a spiral spring of being drawn out a distance proportional to the

[9] *Comptes rendus*, vol. cix., p. 453, 1889. Math. and Phys. Papers, vol. iii., p. 466.
[10] Proceedings of the Royal Society of Edinburgh, vol. xi., 1890.
[11] Vol. i., p. 237, *et seq.*

weight hung on the lower hook. The gyrostatic arrangement is very difficult to realise with ordinary gyrostats, but presents no difficulty with our motor instruments. You see what the arrangement is. A frame of four equal bars is constructed, by jointing the bars freely together at their extremities in the manner shown by the diagram. It is hung from a vertical swivelling pin at one corner, so that one diagonal of the frame is vertical, and another vertical swivelling pin at the lowest corner carries a hook. Four equal gyrostats are inserted, one in each bar, as shown, with its axis along the bar, and they have equal rotations in the directions shown by the circular arrows. Under the couples tending to change the directions of the axes of the flywheels, and applied by the weights of the gyrostats and bars, the system precesses round the two swivels, and so preserves a constant configuration. If now a weight is hung on the hook at the lower end, the frame is elongated a little, and a new precessional motion gives again a constant configuration of the frame, different, of course, from the former one. Two gyrostats, the upper or lower pair, would serve quite well to give the effect.

Lord Kelvin suggested that if the frame were surrounded by a case, leaving only the swivel-pins at top and bottom protruding, it would be impossible, apart from special knowledge of the construction of the interior, to discern the difference between the system and an enclosed spiral or coach spring, surrounded by a case and fitted with hooks for suspension and attachment of weights. But unless the masses of the gyrostats are very small (while their angular momenta are exceedingly great), so that the change of kinetic enegy due to the change in precessional motion may be put down entirely, or nearly so, to the work done by gravity on the weight carried by the hook, in its descent from one configuration of steady motion to another, the distance through which the frame is lengthened is not simply proportional to the load applied.

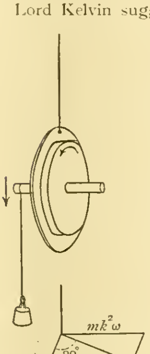

FIG. 6.

A fair idea of the action, and, indeed, an approximate realisation of the property aimed at, is obtained by means of the arrangement shown in Fig. 6 above. We have had it before. A gyrostat is hung with its axis horizontal by a cord in the same vertical as the centroid. The flywheel spins, but as there is no couple there is no precession. A weight mg is applied in a vertical line at distance l from the centroid, as indicated by the diagram; a slight, very slight, tilting of the gyrostat is produced, and the gyrostat moves off with not quite steady precession, of average angular speed μ. Neglecting the slight deviation now set up of the suspension cord from the vertical, and putting A for the moment of inertia of the gyrostat about a vertical axis through its centre, we get for the kinetic energy of the azimuthal motion the value $\frac{1}{2}A\mu^2 + \frac{1}{2}ml^2\mu^2$. The work done by the weight mg in its descent through the small distance h involved in the tilting is mgh. Hence we get $\frac{1}{2}(A+ml^2)\mu^2 = mgh$.

As we have already seen, however, we have in this case $\mu = mgl/Cn$. Substituting in the equation just found this value for μ, and supposing that A is great in comparison with ml^2, so that the term $\frac{1}{2}ml^2\mu^2$ may be neglected, we find after a little reduction the equation—

$$\frac{m}{h} = 2\frac{C^2 n^2}{A l^2 g}.$$

Thus h is proportional to m.

It will be evident that if on the right-hand side of the first equation there had been terms due to descent of the gyrostat through a distance of $\frac{1}{4}h$ or $\frac{3}{4}h$, this equation of proportionality could not have been obtained.

The idea, however, underlying the arrangement is very suggestive, and carries us a long way towards obtaining a definite notion as to how the elastic properties of bodies may be explained.

(A gyrostatic pendulum was here shown. See for figure and description NATURE, April 17, 1913.)

VII. *Vibrations and Waves in Stretched Chain of Gyrostats.*

[An account of this paper was given in the lecture, and will be found (with details of the mathematical discussion appended) in the *Journal* of the Institution of Electrical Engineers.]

VIII.—*Gyrostatic Observation of Rotation of the Earth.*

The famous French experimentalist, Léon Foucault, suggested two ways of determining the rotation of the earth. One was observation of the apparent turning of the plane of vibration of a long pendulum, suspended so as to be as nearly as possible free from any constraint due to the attachment of the pendulum wire to its fixed support. This classical experiment was carried out with fair success at the Panthéon at Paris, and was repeated under the domes of the cathedrals of Amiens and Rheims. If the exponents of "Kultur" in Northern France were aware of this fact, they seem to have attached to it just as little weight as they gave to the more sacred associations of the beautiful old church of the latter city.

Foucault's other method was based on the fact that a gyrostat, if mounted properly, retains unaltered the direction of the spin-axis when the supports are turned round. Here, for example, is our pedestal gyrostat, mounted freely in its enclosing frame which is carried by a vertical rod, swivelling in a vertical socket carried by the supporting stand (see Fig. 7 above). I can set the spinning gyrostat with its axis in any direction I please, and, when I turn the supporting stand round, a friction couple of some little magnitude is applied to the vertical rod. You see that I do not alter the direction of the spin-axis perceptibly. Yet the friction couple is sufficient to carry the gyrostat round with the stand when there is no spin. The spin results in a great increase of virtual inertia for turning displacements, as we shall see quantitatively in the case of one of Lord Kelvin's experiments, which I am about to describe.

In practice it is found desirable to subject the gyrostatic apparatus to a constraint which is perfectly definite; for example, the axis of spin may be kept horizontal. Solutions of the problem are to be found in the gyrostatic compasses now in use on the warships of various navies.

At the British Association meetings at Southport and Montreal, in 1883 and 1884, Lord Kelvin suggested methods of demonstrating the earth's rotation, and of constructing a gyrostatic compass. One of these had reference to the component of rotation about the vertical, the component, in fact, demonstrated by the Foucault pendulum experiment. If ω be the resultant angular speed, the component about the vertical at any place in latitude l is $\omega \sin l$, while the companion component about the horizontal there is $\omega \cos l$. Thus at London the component about the vertical is 0·78 of ω, and the period of rotation about the vertical is about 30·77 hours of sidereal time.

Lord Kelvin's method of measuring $\omega \sin l$ consists in supporting a gyrostat on knife-edges attached to the projecting edge of the case, so that the gyrostat without spin rests with the axis horizontal or nearly so. For this purpose the line of knife-edges is laid through the centre of the flywheel at right angles to the axis, and the plane of the knife-edges is therefore the plane of symmetry of the flywheel perpendicular to the axis. The knife-edges are a little above the centre of gravity of the instrument, which we suppose in or nearly in that plane, so that there is a little gravitational stability. The azimuth of the axis is a matter of indifference, as any couple due to the component of rotation about the horizontal is balanced by an equal couple furnished by the knife-edge bearings.

At points in a line at right angles to the line of knife-edges, and passing through it, two scale-pans are attached to the framework, and by weights in these the axis of the gyrostat (without spin) is adjusted, as nearly as may be, in a horizontal position which is marked. The gyrostat is now removed, to have its flywheel spun rapidly, and is then replaced. It is found that the weights in the scale-pans have to be altered now to bring the gyrostat back to the marked position. From the alteration in the weights the angular speed about the vertical can be calculated.

To fix the ideas, let the gyrostat axis be north and south, and let the spin to an observer, looking at it from beyond the north end, be in the counterclock, or positive direction. The rotation of the earth about the vertical carries the north end of the axis round towards the west, and therefore angular momentum is being produced about a horizontal axis drawn westward, at a rate equal to $C n \omega \sin l$, where C is the angular momentum of the flywheel. If the sum of the increase of weight on one scale-pan and the diminution (if any) in the other be w, and a be the horizontal distance between the points of attachment of the scale-pans, we have

$$C n \omega \sin l = w g a.$$

Thus if C and n are known, $\omega \sin l$, or ω, can be calculated.

Lord Kelvin does not give any figures as to the forces to be measured in a practical experiment; but I can supply these. We may take the mass of a small flywheel as 400 grammes, its radius of gyration as 4 cm., and its speed of revolution, if high, as 200 revolutions per second. If we take a as 10 cm. we obtain for London the equation

$$400 \times 4^2 \times 400\pi \times \frac{2\pi \times 0{\cdot}78}{80160} = 10 \times 981 \times w.$$

This gives $w = 0{\cdot}047$ gramme, or 47 milligrammes. It would require careful arrangements to carry out the experiment accurately, but the idea is clearly not unpractical. With some of the new gyrostats that we now have, the mass of the wheel is as much as 2000 grammes, and the radius of gyration is about 7·5 cm. These numbers bring w up to 0·82 gramme, at the same speed.

If the gravitational stability of this gyrostatic balance be removed, that is, the line of knife-edges be made to pass accurately through the centre of gravity of the system of wheel and framework, and the axis of the wheel be placed in a truly north and south vertical plane, so that the knife-edges are horizontally east and west, the gyrostat will be in stable equilibrium when the axis is parallel to the earth's axis, and is turned so that the direction of rotation agrees with the rotation of the earth. For we have then simply the experiment, described above, of the gyrostat mounted on trunnions resting on bearings attached to a tray which is carried round by the experimenter. The axis of the gyrostat was at right angles to the tray, and we saw that when the tray, held horizontally, was carried round in azimuth the equilibrium of the gyrostat was stable or unstable, according as the two turnings agreed or disagreed in direction. In the present case the tray is the earth, the position of the axis of rotation parallel to the earth's axis replaces the vertical position, and the earth's turning the azimuthal motion. If displaced from the stable position the gyrostat will oscillate about it in the period $2\pi\sqrt{A/Cn\omega}$, where A is the moment of inertia about the knife-edges, and the other quantities have the meanings already assigned to them.

If the line of knife-edges be north and south, the vertical will be the stable, or unstable, direction of the axis of rotation, and there will be oscillation about the stable position in the period

$$2\pi\sqrt{A/Cn\omega \sin l}.$$

The gyrostat thus imitates exactly the behaviour of a dipping needle in the earth's magnetic field, and thus we have Lord Kelvin's gyrostatic model of the dipping needle.

It is right to point out that these arrangements were anticipated by Gilbert's barogyroscope,[12] which rests on precisely the same idea, and applies it in a similar manner.

IX.—*Gyrostatic Compass.*

At Montreal Lord Kelvin described a "gyrostatic model of a magnetic compass." This was one of his gyrostats hung, with its axis of rotation horizontal, by a long fine wire, attached to the framework at a point over the centre of gravity of the system, and held at the upper end by a torsion-head capable of being turned round the axis of the wire. By means of this torsion-head any swinging of the gyrostat in azimuth round the wire was to be checked until, when the head was left untouched, the gyrostat hung at rest.

In small azimuthal oscillations of the gyrostat about the axis of the wire, the wire being fixed to the gyrostat at the lower end and held by the head at the upper, the virtual moment of inertia of the gyrostat about the wire is greatly enhanced by the rotation of the flywheel. If there were no rotation the moment of inertia would be A; with rotation it is virtually $A(1 + C^2n^2/AMag)$, where M is the whole suspended mass, a the distance of the point of attachment of the wire above the centre of gravity of the mass M. This will be found proved very simply in the Mathematical Appendix [see *Journal*, I.E.E.] to this lecture. It will be shown, moreover, that when the whole motion is considered—the tilting motion as well as the azimuthal—it appears that there are two fundamental periods of vibration. There is the long period due to the slight torsional rigidity of the long wire, and the enhanced moment of inertia pointed out by Lord Kelvin, and also a short period, the shortness of which is most properly to be reckoned as due to virtual diminution of the moment of inertia of the gyrostat, in the tilting motion, in exactly the same ratio as the other moment of inertia is increased. Both these periods are separately possible, and in

12 "Mémoires sur divers problèmes," etc. *Annales de la Société Scientifique, Bruxelles*, 1877–8.

the most general motion they are superimposed. This second curious effect was not referred to by Lord Kelvin, and I have not seen it noted before. The co-existence of long and short periods is, however, characteristic of rapidly spinning gyrostatic systems.

Now suppose that the wire so long and of so slight torsional rigidity that this rigidity cannot stabilise the gyrostat in the position of unstable equilibrium. Then the effect of the component of rotation of the earth about the vertical is to produce tilting of the axis of the flywheel from the horizontal position, since this turning gives a rate of production of angular momentum about a horizontal axis at right angles to that of rotation. A slight tilt suffices to give an equilibrating couple, and so we can have the gyrostatic axis in a north and south vertical plane, and nearly horizontal, while the wire is without twist. Into this position the gyrostat is guided by manipulation of the torsion-head. The effect of the horizontal component of the earth's angular speed is now practically zero.

If now by the use of the torsion-head the gyrostat axis be brought to rest in a nearly horizontal position at an angle ϕ with the north and south horizontal direction, the component of turning about this position of the axis is $\omega \cos l \cos \phi$, and about a horizontal line at right angles to the new position of the axis is $\omega \cos l \sin \phi$. The former has no influence on the gyrostatic axis, the latter gives a rate of production of angular momentum about the vertical amounting to $C n \omega \cos l \sin \phi$. Hence a couple of moment equal to this must be applied by means of the torsion-head to produce equilibrium, and this as we see is proportional to $\sin \phi$.

X.—*General Dynamical Theory of Gyrostatic System with any Number of Freedoms.*

I cannot do more than mention the gyrostatic investigations contained in the second edition of "Natural Philosophy." These were written while the proofs of § 345 of the book were in his hands, and consist of additional sections (§§ 345^{i}–345^{xxviii}) interpolated at that stage. From many points of view this part of the book is exceedingly interesting. It continues a subject which was also expanded in the same way on the proof-sheets (in §§ 343*a*–343*m*), that of oscillatory motion. Oscillatory motion for systems of two, three, four, six, or more freedoms with gyrostatic domination is enough to tax the skill of the most expert analyst, for questions arise regarding the roots of the determinantal equations and their interpretation, which require great care in handling. I may only quote the general conclusions as to gyrostatic domination.

Let the number of the freedoms be even (that is, the freedoms exclusive of those by which the flywheels have angular momenta about their axes). Let the equilibrium of the system when at rest (without spin of the flywheels) be either stable, or unstable, for every freedom. If the wheels are so linked up to the system as to render gyrostatic domination possible, then with sufficiently rapid spin the equilibrium becomes stable, with half the whole number, $2n$ say, of its periods of vibration exceedingly small, and the other half very large. Each set of periods is given by the roots of a determinantal equation of degree n. The latter periods are to the first degree of approximation independent of the applied forces, and were called "adynamic," the former periods were called "precessional," and do depend on the applied forces.

The first approximations to the fast and slow azimuthal motion of a top are in point. The angular speed $Cn/A \cos \theta$ does not depend on any applied forces, the other speed Mgh/Cn does.

XI.—*Difficulties of Mechanical Hypotheses and Models. Conclusion.*

I have now dealt with most of Lord Kelvin's investigations and theories. These were related in many ways to electricity and magnetism, and in all of them he ever sought some dynamical explanation that would work. This, indeed, was the distinguishing feature of all his researches, the bringing of everything down to dynamics, and the construction where possible of illustrative mechanical models. Electricity and magnetism are highly dynamical affairs; we send signals by wire or "wireless," we transmit power in a wonderful manner by an agency which we are still far from completely understanding, an agency which causes absorption of energy at one place on the earth's surface, and evolution again of a large portion ot that energy at another place. The vehicle is the æther, for, in spite of all that I have been able to learn regarding the new theory of relativity, I still believe in the æther's existence. In all this we are held fast by dynamical laws, no doubt not yet formulated in full detail, but to a considerable extent already correctly comprehended.

* * * * * *

Lord Kelvin certainly had confidence in his own theories and clung firmly to his conclusions. He was *tenax propositi*, yet he could on occasion acknowledge that he had made a mistake. His genius ranged over the whole field of physical science; no problem was too great or too small to attract his attention. No obstacles, no complications, daunted his spirit of inquiry. The thunders of Jove, the birth of the world and the cold death prepared for it by dissipation of energy, the harnessing of the energies of nature for the service of man, the guidance and safety of mariners, the genesis of waves and their breaking into spray and spindrift, all these questions, and many others, engaged his thoughts, to the lasting benefit of humanity and the increase of knowledge. Throughout all he was keen and calm and dispassionate, a truly unaggressive and kindly natural philosopher.

The function of science is to enable man to penetrate the secrets of nature, and to apply that knowledge to the promotion of the welfare and happiness of all living beings. No one would have repudiated with more scorn than Lord Kelvin that emanation of the Pit, the modern doctrine that culture—scientific, philosophical, or artistic—entitles a self-appraised and self-chosen nation to wade through seas of blood to the domination of the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The report of the Military Education Committee to the Senate of the University for the year 1914 shows that very valuable service has been rendered to the country by the University Contingent of the Officers Training Corps. The number of cadets and ex-cadets of the Contingent gazetted to commissions between August 5, 1914, and the end of the year was 773, and the number of graduates and students of the University (not being past or present cadets of the O.T.C.) gazetted to commissions during the same period was 156. Allowing for officers commissioned from the O.T.C. before August 5, the total number of officers now serving, who are ex-cadets of the University of London O.T.C., or were recommended for their commissions by the University, is estimated at 1100. In addition, a large number of graduates and students of the University have been granted commissions through other channels or are serving in the ranks. We notice with regret that the following officers who proceeded to commissions from the University of London O.T.C. are reported killed:—2nd Lieut. T. R. Bottomley, Birkbeck College; 2nd Lieut. J. S. Paulson, University College; Lieut. C. D. Sneath, University College; 2nd Lieut. C. F. Shaw, King's College; 2nd Lieut. M. A. P. Shawyer, East London College; and 2nd Lieut. P. J. Whitehouse, East London College.

The Commanding Officer of the University O.T.C. Lieut.-Col. D. S. Capper, announces that a limited number of young men who are not students of the University will be enrolled for a course of continuous training with the view of qualifying for commissions. Candidates, who must be between the ages of 18 and 28 and suitable in every respect for commissions in the Army, should attend in person to see the Adjutant of the Contingent at the Headquarters, University of London, South Kensington. The next course of continuous training will commence on March 15.

The Senate on February 24 appointed Dr. C. K. Tinkler, D.Sc. (Birmingham), to the readership in chemistry, tenable in the home science department of King's College for Women.

The D.Sc. degree in biological chemistry was granted to R. V. Norris (Lister Institute), and in physics to A. H. Ferguson.

An interesting series of special lectures dealing with questions of social service is at present being conducted at the Municipal Technical Institute, Belfast. The problems created by the war have aroused much interest in social work, and have attracted into the field of social service large numbers of voluntary workers. Amongst these workers the need is being increasingly felt for a better understanding of the principles which should be followed and of the methods which should be employed in social effort, as well as for a fuller knowledge of the local facilities already existing for the amelioration of distress. It is to meet the urgent call for such knowledge that the authorities of the institute have established the lectures. The programme of the series, issued in pamphlet form and containing abridged syllabuses, shows that the course takes a very comprehensive view of the whole subject. The lectures fall naturally into three main groups. The first group deals with fundamental and general questions relating to social service, the second group deals with municipal and State effort, and the third group treats of voluntary agencies. The value of the programme is enhanced by the inclusion of lists of the books on social subjects which are available in the library of the institute and in the public libraries of the city. The first lectures of the series have been exceptionally well attended, and it is hoped that the outcome of the series will be the establishment of systematic courses of instruction in various branches of social science. More than six hundred members of the staff and of present and former students of the institute are serving with the naval and military forces of the Empire.

The debate in the House of Commons on Friday last on the vote for the Civil Service and Revenue Department was mainly occupied with the question of the alleged shortage of adult labour in agricultural districts and the attempt of farmers to induce the Boards of Agriculture and of Education to look with favour on the exploitation of children to take the place of men who have enlisted. It is satisfactory to learn that neither of the Boards in question shows much inclination to relax the conditions under which children are now allowed to leave school for full-time work, yet it is nevertheless disquieting to find that in some rural areas it is almost impossible to get magistrates to convict for breaches of the school bye-laws. The results of the war have not placed farmers in a disadvantageous position as regards prices; on the contrary, as is well known, the price of wheat and other produce has almost doubled since the war began, and the farmer has thus little reason to refuse a substantial advance in wages such as would induce the labourer in the town to return to the countryside. Moreover, the question as to whether there is a material shortage is not beyond doubt, since it is stated that not more than three per cent. of farm labourers have joined the forces. The cry for child labour comes mainly from the southern counties, where it is admitted that the rate of payment is greatly below that of the north and in Scotland. In any case, before the child is exploited the labour of women at an adequate rate demands to be considered. Having regard to the fact that this war is making a heavy drain upon some of the best elements of the industrial population the nation cannot be indifferent to the well-being of the children, both physically and intellectually. Everything that is possible, no matter how great the sacrifice of material interests, should be made to conserve both. We are at war with the best-instructed nation of the world, and we cannot be too considerate of the present welfare of the nation's children, having regard to the heavy responsibility the future will place upon them.

The second reading of the Universities and Colleges (Emergency Powers) Bill was agreed to by the House of Commons on Tuesday, March 2. The Bill gives the Universities of Oxford and Cambridge power to postpone the date of the determination of scholarships in order to enable their holders to enjoy them when they return from the war. In the same way, power is given to suspend the statutory conditions as to residence; to enable the richer colleges to make up the deficit in the tutorial fees by taking money from their endowments, and the poorer colleges to postpone repayment of capital; the power to make emergency statutes, and so on. In moving the second reading of the Bill, Mr. Asquith said that the total number of members from each University serving in the Army and at the front is approximately 6000. The total number of undergraduates in residence at Cambridge a year ago was 3181. It is now 1227. The figures for Oxford are approximately the same. This means that two-thirds of the undergraduates from the two great Universities have volunteered for service, and are now serving their country in the Army. Nearly all the physically fit undergraduates in residence both in Oxford and Cambridge have joined the Officers Training Corps, and many of the University buildings have been given up for military purposes. This transformation in the whole aspect and conditions of university life has exposed both the Universities as a whole and their constituent colleges to great difficulties and pecuniary embarrassments. At Cambridge the fees normally payable in the scientific department of the University are 26,000*l*. a year; and it is estimated that this year less than 15,000*l*. will be paid; while other fees, usually amounting to 35,000*l*., the University authorities estimate will be no more than 15,000*l*. In supporting the Bill, Sir Joseph Larmor said that when the war is over it will be the duty of the country to see that the standard of British learning and science is maintained before the world. It will be the duty of this nation more than ever before to see that the things of the mind are attended to after we have obtained success in the material prosecution of the war.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 25.—Sir William Crookes, president, in the chair.—Prof. L. **Hill** and J. F. **Twort**: The effect of the depth of pulmonary ventilation on the oxygen in the venous blood of man.—J. **Barcroft** and Toyojiro **Kato**: The effect of functional activity upon the metabolism, blood flow, and exudation in organs. The organ studies have been skeletal muscle and the submaxillary gland. (1) The oxygen used by these organs not only increases during their activity but outlasts it by some hours. The curve of oxidation usually shows two maxima, the first during the period of activity, the second much later. (2) water leaves the blood-vessels in much greater quantities during and after activity of the organs than before; a similar second maximum is sometimes seen in the case of the exudation. (3) In the case of muscle not all the exudation leaves the muscles as lymph. Of the right and left gastrocnemius muscles, the one which has been stimulated is heavier several hours after the stimulation, and of lower specific gravity than the unstimulated one. (4) The dilatation of the vessels of the organ outlasts the functional activity for two hours or more in the case of muscle which has been stimulated rhythmically for fifteen minutes. (5) The tenseness of the muscle caused by its distension with water would seem to be the physical basis of stiffness.—Miss D. Jordan **Lloyd**: The osmotic balance of skeletal muscle. In order to free the phenomena as far as possible from complications due to the formation of diffusion columns, a very small flat muscle—the sterno-cutaneous of the frog—was used. The results of experiments show that an oxygen-saturated muscle has an osmotic equivalent less than that of distilled water.—Dr. A. J. **Ewart**: The function of chlorophyll. Previous observations of the author have tended to support the theory that chlorophyll is a stage in photosynthesis. The present paper develops this idea further. By means of Wellstätter's methods of extraction and separation, chlorophyll, carotin, and xanthophyll were obtained in the pure state and used for the experiments. The following conclusions were reached:—(1) No peroxides, organic or inorganic, are produced during the photo-oxidation of chlorophyll, xanthophyll, and carotin. The oxidising effect of these latter substances on potassium iodide when they are undergoing oxidation in the light is due to the fact that in the presence of abundant oxygen they can act as oxidases, not only to themselves, but also to substances with which they may be in contact, such as hydriodic acid, litmus, or guaiacum. (2) Chlorophyll and xanthophyll decompose during photo-oxidation into (*a*) solids, and (*b*) a gas. The solids are colourless, waxy substances and hexose sugars. The gas is formaldehyde gas. With dry films in dry air free from CO_2 relatively more formaldehyde is produced and less sugar. (3) Carbon dioxide combines with chlorophyll, forming xanthophyll and a colourless waxy solid. The combination only takes place actively in the presence of water, and is accelerated by sunlight.—A. **Compton**: The influence of the hydrogen ion concentration upon the optimum temperature of a ferment.—M. **Back**, K. M. **Cogan**, and A. E. **Towers**: Functional œdema in frogs. If the gastrocnemius muscle of a frog be stimulated for fifteen minutes with forty induction shocks per minute it becomes heavier than the other. The difference in weight may amount to upwards of 20 per cent. of the weight of the muscle. The specific gravity falls correspondingly. This phenomenon may be noticed from fifteen minutes after the stimulation ceases to six hours. After sixteen hours the œdema has passed off.

Physical Society, February 12.—Dr. A. Russell, vice-president, in the chair.—A. **Campbell Swinton**: A galvanic cell which reverses its polarity when illuminated. If two plates—one of zinc and the other of tinned copper coated on one surface with selenium and varnished with enamel over the remainder of its surface—are immersed in tap-water, the electric current through a galvanometer connected to the plates shows that in the dark the zinc is electro-positive to the selenium, while the result of light falling on the selenium is to increase the effect. If, however, instead of zinc, carbon or copper is employed for the non-coated plate, the interesting result is obtained that, while the selenium proves to be electro-positive to the carbon or copper in the dark, it immediately becomes electro-negative to carbon or copper the moment it is illuminated, this being easily shown by the deflections of the galvanometer in contrary directions as the light is turned on and off.—Prof. S. P. **Thompson**: On the criterion of steel suitable for permanent magnets. Whatever the form to be given to a permanent magnet, the prime requisites as to the quality of the steel are (1) large remanent magnetism ($\mathfrak{I}_{\text{rem.}}$) and a high coercive (force $\mathfrak{H}_c$). Since Hopkinson's determinations of 1885 it has been supposed that for the purpose of making permanent magnets the best material would be that for which both of these quantities and, consequently, their numerical product, should be as high as possible. Recently Mr. J. A. Mathews and, independently, Mr. J. R. Ashworth, have proposed to take the ratio $\mathfrak{H}_c \div \mathfrak{I}_{\text{rem.}}$ or $\mathfrak{H}_c \div \mathfrak{B}_{\text{rem.}}$, which only differs in scale as the criterion. To decide as to the suggestion to take the ratio instead of the product a table giving the values of $\mathfrak{H}_c, \mathfrak{I}_{\text{rem.}}$ $\mathfrak{H}_c \div \mathfrak{I}_{\text{rem.}}$ and $\mathfrak{H}_c \times \mathfrak{I}_{\text{rem.}}$ for a number of steels is given, and it is clearly shown that the use of the ratio as a criterion of magnetic usefulness leads to most absurd results. As an example, annealed manganese steel (almost non-magnetic) should, judging from the ratio, be six times as good as Remy steel, whereas in reality, for equality of pull, a magnet of manganese steel would require to be 312 times the weight of that made of Remy steel. The qualities requisite in an ideal steel for permanent magnets are indicated.—A. B. **Wood** and A. I. **Steven**: An investigation of the photographic effect of recoil atoms. The ionising, phosphorescent and photographic effects of the α-particles from a radio-active substance entirely cease when the particle still retains about 40 per cent. of its kinetic energy. It appears possible, therefore, that the recoil atoms from a radio-active source should be able to affect a photographic plate, for though the range of a recoil atom is only about 1/500th of that of the α-particle shot off from it, the ionising effect has been shown by Wertenstein and one of the authors to be 10 times as powerful over the corresponding range as that of the α-particle. Attempts have, therefore, been made to demonstrate this action in the case of the recoil atom from polonium, this substance being chosen on account of the inactive nature of the recoiling atom. Two distinct methods were employed: (1) The recoil atom was "absorbed"; (2) the difference of deflection of the α-particle and the recoil atom in a strong magnetic field was utilised in order to attempt to separate their effects. "Schumann" plates were used as being most easily penetrable, but in all cases the results were negative or inconclusive. This is probably due to the fact that the recoil atoms are not able to penetrate sufficiently deeply into the sensitive layer to render the grains developable.

Linnean Society, February 18.—Prof. E. B. Poulton, president, in the chair.—Harold **Wager**: The action of light upon chlorophyll. By making a film of chlorophyll upon paper and on glass, by floating an alcoholic solution, and allowing it to dry, the author was able to bleach a portion under strong sunlight, and covering a portion by black paper; when this was tested by Schiff's solution, the exposed, that is, the bleached portion, became pink, the unexposed portion showing no colour change. Another experiment was made by subjecting similarly bleached portions of chlorophyll to the action of potassium iodide, when the exposed parts turned reddish-blue, in consequence of the liberation of iodine, which acts upon the starch on the paper. The experiments clearly show that the decomposition of chlorophyll is accompanied by the formation of an aldehyde and of something able to oxidise the potassium iodide and to set free the iodine. Instead of alcoholic extract of chlorophyll we may use dried leaves, or chlorophyll expressed from leaves, or layers of Euglena or algæ spread over the paper. The reactions also take place inside a leaf, if the bleaching has been efficient. Thus if sunlight is condensed by a lens upon a living leaf of *Oxalis acetosella* containing plenty of starch, the chlorophyll is bleached in a small area, and if treated with Schiff's solution, a strong aldehyde reaction results; if tested with potassium iodide the said area becomes blue. It having been stated that formaldehyde is produced when chlorophyll is exposed to sunlight in the presence of carbon dioxide, an attempt was made to determine whether such was the case in the present series of experiments, but the author was not able to satisfy himself on this point, though several of the tests succeeded even with so small an amount as one-millionth of formaldehyde. Hydrogen peroxide had been suggested as the gaseous oxidising compound of chlorophyll, but the result of many varied tests showed that this was not so.

MANCHESTER.

Literary and Philosophical Society, February 9.—Mr. F. Nicholson, president, in the chair.—Dr. T. Graham **Brown**: Note on the physiology of "walking," with especial reference to its occurrence in the unborn fœtus of the cat. The various reflexes have been examined in cat fœtuses. The red nuclei seem to be capable of stimulation, and evoke their characteristic movements of the fore-limbs. The limb reflexes are very similar to those of the adult cat. The ipsilateral flexion-reflex and the contralateral extension-reflex have thus been observed. In the former reflex an extension rebound effect has been seen. Reflex inhibition may be observed on pitting one reflex against another. If the fœtus is shelled out of the uterus without delay into warm physiological salt solution it may be regarded as still unborn. In these circumstances unmistakable movements of progression may be obtained on producing asphyxia by pressure upon the umbilical cord. They may sometimes appear to arise spontaneously. This observation shows that the mechanism for co-ordinate progression develops during intra-uterine life, and that the co-ordination of the mechanism is not conditioned after birth by a process of "learning." The observation also shows that the rhythmic activity may be evoked by the general stimulus of asphyxiation before it has been evoked or conditioned by any rhythmic self-generated peripheral stimuli such as those which play an important part in normal progression, but have been shown not to be its intrinsic factors. It thus also gives another demonstration of the similarity between the respiratory mechanism and that for progression.—Prof. G. Elliot **Smith**: The Darling Downs skull. Photographs were shown of a completely mineralised human skull, which had been found near Warwick in the Darling Downs of Queensland, and was described by Profs. Edgeworth David and Wilson at the recent meeting of the British Association in Australia. This important discovery of the earliest human remains yet known in Australia seems to prove that Man reached Australia at a time when the great fossil marsupials were still living.

DUBLIN.

Royal Dublin Society, February 23.—Prof. Wm. Brown in the chair.—Prof. Grenville A. J. **Cole**: The mode of occurrence and origin of the orbicular granite of Mullaghderg, Co. Donegal. The structure and mineral characters of this rock were described by Dr. F. H. Hatch in 1888. A recent visit by the Geological Survey has enabled large specimens to be procured, the surfaces of which have been polished. The nucleus in several of the large spherulites is seen to be a flake of schistose rock. In most cases, however, it consists of granite, somewhat poorer in biotite than the granite which includes the spherulitic bodies. The very local occurrence of this orbicular rock as a variation on the general red granite of the district leads to the conclusion that the spherulitic bodies represent inclusions from the roof of Dalradian schists which once overlay the granite cauldron. Such inclusions may have fallen in from a cold portion of the roof and thus promoted a rapid crystallisation of oligoclase round about them by interaction of their constituents and those of the granite magma. Blocks of already cooled granite may have fallen back also from the roof of the dome, and may have supplied nuclei for spherulitic growth. The occurrence of granite round about schist-fragments, and surrounded by a zone of radial oligoclase, suggests, however, an interchange of material between the granite and the schists. Granitic material seems to have soaked in while more basic material moved outwards to form the radially crystalline zone. Experiments by Tenow and Benedicks and by Endell are referred to: but no explanation can be offered as to why orbicular structure is so rare a phenomenon.

EDINBURGH.

Royal Society, February 1.—Sir E. A. Schäfer, vice-president, in the chair.—Mrs. Rosalind **Jones** (*née* Crosse): Studies on periodicity in plant growth. Part ii. Correlation in root and shoot growth. In a former paper the fact of a four-days' periodicity in plant growth had been established; and in the present continuation the subject was further investigated. It was found that artificial changes in environment as regards heating and illumination did not affect the periodicity, and that there was correlation in the root and shoot growths.—Dr. J. **Dawson**: The histology of disseminated Sclerosis. This investigation, which had been partly outlined by the late Dr. Alexander Bruce, was based on an extended pathological observation disseminated sclerosis. This investigation, which had been studied largely by the method of serial sections stained by modern neuro-histological technique; and complete sections through the cerebral hemispheres, or large portions of the central nervous system, had been used to elucidate the distribution of the patches. Although no complete interpretation of the subject could be given, or no uniform conception of the process offered, certain conclusions were formulated, of which the following may be noted. The process underlying disseminated sclerosis is a sub-acute disseminated encephalo-myelitis, which terminates in areas of actual and complete sclerosis. There is overwhelming evidence that the great majority of the areas arise on the basis of an evolution through a stage of fat granule cell formation. There is much to favour the view that true disseminated sclerosis is due to a specific morbid agent, the nature of which is quite unknown. Histological evidence suggests a soluble toxin, conveyed to the nervous tissues by the blood channel rather than by lymphatics. The fleeting early motor paralysis and psychical symptoms may be related to the presence of areas in association paths, their remission being possibly due to the linking up of other association paths, or their compensation to the opening up of new paths. Although approximate answers may be given to questions relating to the nature of the process, to its origin, and to certain aspects of the mode of action, we are still quite in the dark concerning the nature of the final causal agent, which determines a disease which, however variable the early symptoms, conceals its characteristic course only temporarily.

February 15.—Dr. Peach, vice-president, in the chair.—Dr. H. **Rainy** and Dr. J. W. **Ballantyne**: Skiagraphic researches in teratology. The paper dealt with the abnormal development of bones in the human fœtus, and was illustrated by a number of X-ray photographs of these abnormalities. The facts brought forward opened up important questions in heredity, as well as in development.—Prof. J. **Stephenson**: (1) On *Haemonais laurentii*, a representative of a little-known genus of Naididæ; (2) on a rule of proportion observed in the Setæ of certain Naididæ; (3) on the sexual phase in certain of the Naididæ. An account was given in these connected papers of the various systems of organs and of the process of fission in this group of worms. A curious feature in two of the species described was the degeneration of the alimentary canal as the worm approached sexual maturity. Dr. F. R. Cowper **Reed**: The Ordovician and Silurian Brachiopoda of the Girvan District. In this elaborate memoir about 250 species and varieties were described, of which some seventy were new to science. The greater number of specimens described were from the collection made by Mrs. Robert Gray of Edinburgh, and with these were joined specimens from various museums in Great Britain. The local facies of the fauna were strongly marked; but many of the species, particularly those of Ordovician age, resembled American rather than European types. A characteristic feature was the limitation of distinctive species to successive stratigraphical horizons, a fact which suggested a more extended use of brachiopods for zonal purposes.

PARIS.

Academy of Sciences, February 15.—M. Ed. Perrier in the chair.—L. E. **Bertin**: The transport of marine mines by currents under the action of the groundswell. The upward thrust on the mine due to hydrostatic pressure has been usually calculated from the value in water at rest. The alterations in the thrust due to an oscillatory motion of the water are calculated, and it is shown that to prevent the anchor being lifted its customary weight should be doubled.—C. **Guichard**: Surfaces such that the lines of curvature correspond on the primitive surface, and on the surface locus of the centres of the spheres osculating the lines of curvature of a series of the primitive surface.—Paul **Vuillemin**: The flower. A discussion of the flower in its relation to the leaves.—B. **Jekhowsky**: Observations of Delavan's comet, 1913*f*, made at the Observatory of Paris. Four positions given for January 8 and 11. The comet appeared as a rounded nebulosity of about 30″ diameter with a semi-stellar nucleus. Magnitude 7·5 to 8. No tail.—M. **Alezais**: A property of arithmetical progressions.—M. **Globa-Mikhaïlenko**: Ellipsoidal figures of equilibrium of a fluid mass in rotation when capillary pressure is taken into account. It is shown that the only ellipsoidal figure of equilibrium assumed by a fluid mass in rotation, if the surface tension is taken into account, is the cylinder of revolution.—A. **Guillet**: Wheel with harmonic teeth, application to the construction of a laboratory chronometer with a uniform and continuous movement.—E. **Mathias**, H. Kamerlingh **Onnes**, and C. A. **Crommelin**: The rectilinear diameter of nitrogen. The densities of liquid nitrogen and its saturated vapour were determined at temperatures ranging from −208·36° C. to −148·08° C., and the values of the ordinate of the diameter were found to be $y=0{\cdot}022904-0{\cdot}0019577\,\theta$. The angular coefficient of the diameter is $\alpha=-0{\cdot}0019577$, and the critical density $\Delta=0{\cdot}31096$. The critical coefficient $\frac{R\Theta\Delta}{\pi}$ is 3·421, or nearly the same as argon (3·424) and oxygen (3·419).—L. **Bouchet**: The deformation of vulcanised indiarubber under the action of an electrostatic field. The variable electrostatic pressures are sufficient to account for the observed facts without any additional hypothesis.—Keivin **Burns**: Interferential measurements of wavelengths in the ultra-violet part of the iron spectrum Data are given for wave-lengths between 2851 and 3701 on the basis of the value 6438.4696 for the red cadmium line.—Henry **Hubert**: Preliminary sketch of the geology of the Ivory Coast.—B. **Galitzine**: The earthquake in Italy on January 13, 1915. Particulars of the records on the seismographs at the Pulkovo Observatory. The position of the epicentre calculated from the seismograms coincided very closely with the region of greatest damage, and it is pointed out that observations from a single station were sufficient for this determination.—Ph. **Flajolet**: Disturbances of the magnetic declination at Lyons (Saint-Genis-Laval) during the second quarter of 1914.—Henri **Coupin**: A marine yeast. The first example of a yeast isolated from sea water, for which the name *Torula marina* is proposed.—M. **Coquidé**: Remark on the nitrification in the peaty soils in the neighbourhood of Laon. The experiments were made on virgin soil and included the addition of potassium chloride or kainit, sodium nitrate, and phosphate slag, the three types being used separately, in pairs, or all together, the last giving the best results. The effect of omitting nitrate was marked, and there appears to be little or no natural nitrification of the nitrogenous material in these soils.—J. **Bergonié**: The mobilisation in the tissues of magnetic projectiles by the repeated application of electromagnetism. To move deeply-seated metallic fragments repeated applications of an electromagnet may be required, leading ultimately to a swelling on the surface exactly localising the fragment, and permitting its easy extraction by a simple operation. Details of cases are given in which the original position of the piece of shell was too deep-seated for direct removal, or in which unsuccessful operations after X-ray localisation had been made.—Raoul **Bayeux**: The treatment of hydrarthosis and hæmarthrosis by intra-articular pneumatic compression by means of oxygen.—A. **Pezard**: The experimental transformation of the secondary sexual characters in the Gallinaceæ.—A. **Sartory**, L. **Spillmann**, and Ph. **Lasseur**: Contribution to the study of typhoid states. Although the causal origin of typhoid fever is the Eberth bacillus, it appears to be probable that the pathogenic power of this organism may be increased by the presence of other micro-organisms, such as *Proteus vulgaris*, a diplococcus described by the authors, and possibly other pathogenic species. It is also possible that life in the trenches may give rise to a new clinical type of typhoid fever.

February 22.—M. Ed. Perrier in the chair.—The president announced the death of E. H. Amagat, a member of the academy in the section of physics.—G. **Mittag-Leffler**: A new theorem in the theory of the series of Dirichlet.—J. **Tavani**: The integral $\Gamma(\rho)$ and its relations with other definite integrals.—Marcel **Baudouin**: The discovery and excavation of a menhir found upright and completely buried in a marine alluvium on the coasts of Vendée.—V. **Lubimenko**: New researches on the pigments of the Chromoleucites.—D. **Olaru**: The favourable action of manganese on the bacteria of the leguminosæ.—Louis **Roule**: A new genus of apodal fishes, and some peculiarities of the biology of these creatures.—G. **Daumézon**: The potato as an agent of dissemination of Friedländer's pneumobacillus in nature, and especially in water.

BOOKS RECEIVED.

Indian Museum. Annual Report, April, 1913, to March, 1914. (Calcutta: Indian Museum.)

Bulletin de l'Institut Aérodynamique de Koutchino. Fasc. v. Pp. 296. (Moscou: I. N. Kouchnéreff et Cie.)

Soil Conditions and Plant Growth. By Dr. E. J. Russell. New edition. Pp. viii+190. (London: Longmans and Co.) 5s. net.

The Carnegie Trust for the Universities of Scotland. Thirteenth Annual Report (for the year 1913–14). Pp. 87. (Edinburgh: T. and A. Constable.)

Practical Science and Mathematics for the Second Year Preliminary Technical or Industrial Course. By E. J. Edwards and M. J. Tickle. Pp. viii+175. (London: G. Routledge and Sons, Ltd.) 1s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 4.

ROYAL SOCIETY, at 4.30.—A Bolometric Method of Determining the Efficiency of Radiating Bodies: Prof. W. A. Bone, Prof. H. L. Callendar, and H. J. Yates.—The Simplification of the Arithmetical Processes of Involution and Evolution: E. Chappell.—The Elastic Properties of Steel at Moderately High Temperatures: F. E. Rowett.—The Laws of Series Spectra: Prof. J. W. Nicholson.

ROYAL INSTITUTION, at 3.—Poetry and War: Sir Herbert Warren.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Suess's Classification of the Eurasian Mountains: Prof. J. W. Gregory.

LINNEAN SOCIETY, at 5.—The Lichens of South Lancashire: J. A. Wheldon and W. G. Travis.—The Germination of Marah (*Echinocystis Marah*, Cogn.): A. W. Hill.—New Types of Stem-anatomy in Cycadeoidea, and a well-petrified new Species: Dr. Marie Stopes.—Description of a new Genus and Species of Terrestrial Isopoda from British Guiana: W. E. Collinge.

FRIDAY, MARCH 5.

ROYAL INSTITUTION, at 9.—Mimicry and Butterflies: Prof. E. B. Poulton.

GEOLOGISTS' ASSOCIATION, at 8.—Geology of the Glasgow District: Prof. J. W. Gregory.

SATURDAY, MARCH 6.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

MONDAY, MARCH 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Our Fisheries and their Geography: Prof. Stanley Gardiner.

TUESDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Photography in Natural Colours: Prof. W. J. Pope.

ZOOLOGICAL SOCIETY, at 5.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Improvement of the River Clyde and Harbour of Glasgow, 1873–1914: Sir Thomas Mason.

WIRELESS SOCIETY, at 8.—Waves: Dr. J. Erskine-Murray.

WEDNESDAY, MARCH 10.

ROYAL SOCIETY OF ARTS, at 8.—Patent Law Reform and the War: J. W. Gordon.

GEOLOGICAL SOCIETY, at 8.—The Plants of the Late Glacial Deposits of the Lea Valley: Clement Reid.—The Genus Lonsdaleia and *Dibunophyllum rugosum* (McCoy): S. Smith.

THURSDAY, MARCH 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera: E. Heron-Allen.—The Occurrence of an Intracranial Ganglion upon the Oculomotor Nerve in Scyllium Canicula, with a suggestion as to its Bearing upon the question of the Segmental Value of certain of the Cranial Nerves: G. E. Nicholls.—Experiments on the Restoration of Paralysed Muscles by Means of Nerve Anastomosis. Part III. Anastomosis of the Brachial Plexus with a consideration of the Distribution of its Roots: Prof. R. Kennedy.—On the Mechanism of the Cardiac Valves. A Preliminary Communication: A. F. S. Kent.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Cooking, mainly from the Consumer's Point of View: W. R. Cooper.

CHILD STUDY SOCIETY, at 6.—*Discussion*: The Care and Development of the Child—during School Age—Treatment Centres and their Possibilities: Miss Margaret McMillan.—Care Committees: Mrs. Evelyn.

FRIDAY, MARCH 12.

ROYAL INSTITUTION, at 9.—Back to Lister: Sir R. J. Godlee.

PHYSICAL SOCIETY, at 8.—(1) The Estimation of High Temperatures by the Method of Colour Identity: (2) The Unit of Candle-power in White Light: C. C. Paterson and B. P. Dudding.—The Relative Losses in Dielectrics in Equivalent Electric Fields, Steady and Alternating (R.M.S.): G. L. Addenbrooke.

MALACOLOGICAL SOCIETY, at 8.—*Helicella crayfordensis*, n.sp. from the Pleistocene deposits of S.E. England: A. S. Kennard and B. B. Woodward.—Further Notes on Radulæ: the Rev. E. W. Bowell.—The Editions of Swainson's "Exotic Conchology": A. Reynell.

ROYAL ASTRONOMICAL SOCIETY, at 5.

SATURDAY, MARCH 13.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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THURSDAY, MARCH 11, 1915.

A TEXT-BOOK OF FORESTRY.

Elements of Forestry. By Prof. F. F. Moon and Prof. N. C. Brown. Pp. xvii+391. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 8s. 6d. net.

THE progress of forestry in the United States is remarkable. It is barely twenty years since the first forest reserve was set aside by the Government at Washington, which to-day controls with a trained staff of foresters about 186,000,000 acres of national forests. Forestry is now a matter of great public interest, and is taught in universities, colleges, and schools, there being no fewer than twenty-three institutions giving degrees in the subject. In addition to numerous bulletins and reports issued by the U.S. Bureau of Forestry, there now appear two professional journals, the *Forest Quarterly* and the Proceedings of the Society of American Foresters. Various text-books on special branches of forestry have been published, but no general handbook suitable to students in America has hitherto appeared.

The "Elements of Forestry," by Moon and Brown, is an attempt to supply this need, and it is very satisfactory as an elementary text-book. It will serve as a good introductory work for professional students of forestry, and covers about as much of the subject as is necessary for students in agriculture. The book is clearly printed and well-illustrated. All the usual divisions of the science and art of forestry are taken up in a series of simple and attractive chapters, at the end of each of which is a short and useful bibliography. Of chapters i. to xiv., which are of universal application, those devoted to the utilisation, technology, and preservation of wood are of special interest; and much praise must be given to the chapter on forest finance, in which the gist of this important matter is expounded in sixteen pages. The attention of landowners and practical foresters may be directed to the example on p. 265, which illustrates the most common problem in forestry finance in England, namely, the estimate of the cost of raising a crop of trees to any given number of years of age, and incidentally determining whether a plantation is a profitable investment or not.

Chapters xv.–xxii., entitled "Regional Studies," deal with the conditions of the forests of the United States, which are divided into seven regions. The description, silviculture, protection, and utilisation of the forests of each region are briefly but adequately dealt with. At the end of the book, in addition to a glossary, there is a collection of useful tables and statistics. The average rate of growth of the important species of trees in the various regions is given in Tables VII.–XI. From this it appears that the most vigorous conifers in each region are as follows, the figures being for average trees 100 years old and grown under forest conditions.

Region	Species	Height in feet	Diameter in inches at $4\frac{1}{2}$ feet up
Pacific Coast......	Douglas Fir	138	20·5
	Western Hemlock	110	15·2
Rocky Mountains	Douglas Fir	86	21·1
	Pinus Murrayana	73	11·2
Northern	*Pinus resinosa*	95	17·6
	Pinus Strobus	92	20·0
Southern............	*Pinus Taeda*	111	24·5

THE LANGUAGES OF SOUTHERN NIGERIA.

Specimens of Languages from Southern Nigeria. By N. W. Thomas. Pp. 143. (London: Harrison and Sons, 1914.) Price 4s. net.

MR. NORTHCOTE THOMAS has given us an exceedingly interesting piece of work in African philology by publishing for a reasonable price what might be called a sketch of the languages of Southern Nigeria between the frontier of the Bantu Cameroons on the east, and the Yoruba country on the west. The same ground was covered in 1888 by the writer of this review, but his work, which would be of interest in comparison with, and supplementary to, that of Mr. Northcote Thomas, was only privately printed by the Foreign Office. Perhaps some day it may be disinterred from a confidential blue-book and produced with other linguistic studies.

Mr. Thomas's specimens (prominent nouns, numerals, pronouns, and such syntax as can be illustrated by a variety of sentences) include nearly the entire range of the Ibô dialects, the languages of the Calabar and Cross River district; the Ijō of the actual Niger mouths, Yoruba of the Lagos vicinity, Sôbô and Kukurúku of the Bini-Edo group, Ibibio of the region between the Calabar estuary and Opôbô, and a number of very interesting semi-Bantu languages on the verge of the Cameroons frontier. Mr. Thomas does not attempt much in the way of classification, but would seem to indicate that he finds a connection more or less close between the semi-Bantu Yala, which lies far to the north of the upper Cross River, and the Edo or Bini group in the western part of Southern Nigeria. No evidence of very close affinity, or of affinity at all, is to be deduced from the actual vocabularies given. Personally, I should have been inclined to regard Yala (which is one amongst Koelle's many interesting vocabularies of 1854, hitherto difficult to locate geographically) as having nothing to do with Edo, but much with the more "semi-Bantu" speech contiguous to it on the east. Not the least interesting part of this useful manual is the identification *and* location of eighteen of Koelle's vocabularies, work which greatly enhances their value to the philologist. In addition, Mr. Thomas introduces us for the first time to several speech forms—languages and dialects—hitherto unknown.

Mr. Thomas's work throws a good deal more light on the semi-Bantu languages in addition to the not-sufficiently-known work of Mr. P. Amaury Talbot. The analysis of the material his vocabularies furnish induces me to account for the semi-Bantu group and cognate languages in two ways:—Some of them, especially in the east and south of their range, may be simply much-worn-down and corrupted real Bantu; relics of the comparatively ancient east-to-west migration, which finally carried a Bantu speech to the Island of Fernando Pô. But the balance of probability, especially in regard to the more northern groups of semi-Bantu, lies in the direction of their being descended from sister languages of the original Bantu mother tongue. They would thus have migrated from north-east to south-west. All such indications seem to lead to the theory that the original home of the Bantu was somewhere in the very heart of Africa, between the basins of the Benue, the Shari, the Mubangi and the Bahr-al-Ghazal. But Mr. Thomas's work further directs our attention to the existence of Bantu roots in Ibô and Gori; and this ancient Bantu influence can, I believe, be traced much farther to the west than the lower Niger.

H. H. Johnston.

HOUSEHOLD INSECTS.

(1) *Insects Injurious to the Household and Annoying to Man.* By Prof. G. W. Herrick. Pp. xvii+470. (New York: The Macmillan Co.; London: Macmillan and Co., 1914.) Price 7s. 6d. net.

(2) *The House-Fly,* Musca domestica, *Linn. Its Structure, Habits, Development, Relation to Disease and Control.* By Dr. C. G. Hewitt. Pp. xv+382. (Cambridge University Press, 1914.) Price 15s. net.

"HOUSEHOLD insects" have, for many years past, attracted the attention of entomologists in North America, and since the publication of the well-known Bulletins of the U.S. Department of Agriculture, by Dr. L. O. Howard and Mr. F. H. Chittenden, on pests of this nature, in 1896, much work of importance has been done, particularly with regard to house-flies and mosquitoes. Students of the subject should, therefore, be grateful to Prof. Herrick for providing a popular and trustworthy account (1) of our arthropodous "messmates" and parasites. In addition to insects in the zoological sense of the term, spiders, mites, ticks, solpugids, scorpions, and centipedes are passed in review, and the British reader cannot but feel that some compensation for not being an American is afforded by the comparatively scanty house-fauna of his native land.

The especial strength of Prof. Herrick's book lies in the directions given for dealing practically with the various pests; systematic and bionomic considerations are, throughout the volume, subordinated to the economic point of view. No fewer than one hundred pages are devoted to house-flies and mosquitoes; the disease-transmitting power of these insects is emphasised, albeit with the minimum of information as to the nature of the micro-organisms that they carry. Doubtless the author has been well advised to lay stress on the habits of the creatures that he describes in their relation to remedial and preventive measures, but if a little more space could have been devoted to the zoological aspects of the subject, the reader would take a more intelligent interest in the practical problems brought to his notice. Each chapter is followed by an "economic" bibliography, and the book is illustrated by more than 150 figures of somewhat unequal merit.

(2) Dr. Gordon Hewitt has, by his researches since 1907, made the House-fly (*Musca domestica*), to an especial degree, his own subject, and his transference from Manchester to Ottawa has not cut him off from an abundant supply of material of this cosmopolitan insect. In the handy volume now before us, all the anatomical and histological descriptions and figures from Dr. Hewitt's previously published works are collected in a convenient form, and a full survey of the latest literature on the house-fly and allied Diptera, together with an account of Dr. Hewitt's own recent investigations, will be found to furnish a store of information for the student. Interest in house-flies during recent years has centred around the possibility of these insects serving as carriers of disease-germs to human food-products, and the critical survey of the newest work on this subject—especially with regard to the prevalence of infantile diarrhœa during the fly season—forms a most valuable section of Dr. Hewitt's

book. Experiments carried on at Ottawa on the distances travelled by marked flies showed various ranges of flight up to 700 yards; observations quoted as made by Dr. Copeman in rural districts in Norfolk give a flight-range of 1700 yards. The book concludes with a discussion of the best methods for destroying fly-maggots and for checking the facilities for the breeding of the insects. Bavaria enjoys the reputation of a noteworthy paucity of flies, "perhaps due to the extreme cleanliness of Bavarian cities." Dr. Hewitt's book can be most heartily commended to all enthusiasts on behalf of public health, as well as to students of the anatomy and life-history of insects.

G. H. C.

GEOGRAPHICAL TEXT-BOOKS.

(1) *A Geography of Australasia.* By Griffith Taylor. Pp. 176. (Oxford: Clarendon Press, 1914.) Price 1s. 6d.

(2) *The Pupils' Class-Book of Geography.* By E. J. S. Lay. England and Wales, pp. 80. Price 4d. The British Isles, pp. 118. Price 6d. The British Dominions, pp. 128. Price 6d. (London: Macmillan and Co., Ltd., 1914.)

(3) *Macmillan's Geographical Exercise Books.* With Questions by B. C. Wallis. i., The British Isles, pp. 48. Price 6d. ii., Europe, pp. 48. Price 6d. iii., The British Empire, pp. 48. Price 6d. (London: Macmillan and Co., Ltd.)

(4) *Bacon's Sixpenny Contour Atlas.* South-east England edition. Pp. 41. (London: G. W. Bacon and Co., Ltd.)

(5) *The Map and Its Story.* Pp. 44. (London: G. W. Bacon and Co., Ltd.) Price 1s. net.

(1) ONCE the pupil or student gets past the general outlines and principles of geography (which are so difficult for the author and teacher to lay down in terms that are otherwise than summary and dull), he ought to find out the real interests and fascination of the subject. A book like Mr. Taylor's will help him to do so. This writer has an unusual faculty for keeping steadily in view the interaction of those phenomena which geographers set out to study, and for picking out the right facts from the special departments of knowledge on which geographers have to draw. He also sets great store by the use of the map to illustrate special points, and in this direction shows considerable originality; the maps are generally clear, though sometimes injudiciously reduced, and occasionally rather severely generalised. The descriptive and explanatory writing could not well be clearer, and this being so, the author is safe in carrying his readers into such unaccustomed topics as that of the paragraphs in which he discusses the former history of river courses and the extent of land, a "journey into past geological times" which is justified, as he is able ingeniously to show the bearing of former physical conditions upon modern communications. This book would be an excellent introduction to Australasia as a special subject.

(2) Both the manner and the matter of Mr. Lay's three little volumes, according to their lights, are fairly satisfactory, and a large number of questions and exercises are provided, many of which will carry the pupil well beyond the scope of the work, and are properly suggestive. Others tend to throw back to the old narrow field of geographical teaching, demanding merely a list (*e.g.*, of "the highest mountains of the Pennine Chain"), while it is difficult to conceive in what possible geographical connection such a question is asked as, "Do you know the name of a Councillor? A Magistrate?" Pieces of poetry are set for learning, but the geographical value of poetry is too often doubtful, especially when its language is as difficult as that of W. J. Mickle's translation of Camoens. The text of these books illustrates at some points one of the geographer's besetting dangers, generalisation; such sentences as "Edinburgh, which is built on the famous Castle Rock"; "The Dominion of Canada is provided with a splendid system of waterways"; in the same country "the various minerals—with the exception of . . . gold and silver—are scarcely worked," are statements which, in the want of qualification, may be highly misleading.

The maps (black and white) in this series are commendable, though we should hesitate to subscribe to the claim that "no atlases or other maps" are "required." A point of some interest emerges on making a comparison of maps in this series in Mr. Taylor's book, and in "The Map and Its Story," presently to be noticed. The desirability is revealed of some attempt at standardising distribution maps. The maps illustrating the vegetation of Australia in these three books are, it is true, laid out on rather different systems, but their methods are sufficiently similar to show how widely divergent are the results obtained. A pupil comparing the three would be excusably "floored" in attempting to gather from them the extent and locality of forest and desert areas, and so forth, in Australia, and the differences are such that one or more of the maps must be very seriously in error.

(3) Mr. Wallis's "Geographical Exercise Books" consist of blank maps (sometimes with contour lines), and on the page facing each map a series of questions or directions as to filling it up and writing notes or exercises on the results obtained and the conditions revealed. Both maps and letterpress appear to be very judiciously chosen or compiled, and in the hands of a pupil of moderate capacity in draughtsmanship the finished product should possess a permanent value.

(4) Messrs. Bacon's "Sixpenny Contour Atlas" is very good, considering its price. It contains thirty-two coloured maps, showing the elevation of the land according to a recognised method, and dealing with the world and its various divisions, in addition to which there are a few maps of a special area, varying according to the pupil's requirements—*e.g.*, the edition under notice is that for south-east England, and contains special maps of that district, while editions for south Scotland, south Wales, and others are promised.

(5) The same firm's publication, "The Map and its Story," does not maintain the standard of the work previously noticed, so far as concerns its coloured maps illustrating climate, vegetation, etc. Some of the printing (*e.g.*, of the natural resources shown in red lettering) is bad, and some of the distribution colouring weak. But the distinctive feature of the work, the letterpress accompanying the maps, explains them very clearly, and ought to fulfil the purpose of guiding students as to what they should look for and find, not only on these, but on other maps.

OUR BOOKSHELF.

Huxley Memorial Lectures to the University of Birmingham. With an Introduction by Sir Oliver Lodge. Pp. 164. (Birmingham: Cornish Brothers, Ltd., 1914.) Price 5*s.* net.

OF the nine memorial lectures which have been delivered, the present volume contains only five. That by Prof. Joly on pleochroic halos does not even mention Huxley's name. Sir Oliver Lodge leads off with Huxley's own defence against the charge of materialism. "There is a third thing in the universe which . . . I cannot see to be matter or force, or any conceivable modification of either." This was consciousness. Sir Michael Foster found in Huxley the "conviction that what began as a search into things physical has become a search into things spiritual." Prof. Poulton points out that Huxley "never committed himself to a full belief in natural selection, and even contemplated the possibility of its ultimate disappearance." We come, in the remarkable paper by Prof. Percy Gardner, to the pith of the matter, "in regard to which words from Birmingham are greatly valued, the study of the subconscious side of man."

Prof. Bergson's lecture on life and consciousness traverses a field antipodal to that of Huxley. Consciousness is "the mind." It "and matter are antagonistic forces." It is at once a "creative force," a "vital impulse," and a "spiritual force." Life is "nothing but consciousness using matter for its purposes." It "cuts it up in order to bring about a greater precision." "The evolution of life . . . suggests to us the image of a current of consciousness which flows down into matter as into a tunnel." The final conclusion is "that with man consciousness has finally left the tunnel" to "pursue its path beyond this earthly life."

Dew-Ponds—History, Observation, and Experiment. By E. A. Martin. Pp. 208. (London: T. Werner Laurie, Ltd., n.d.) Price 6*s.* net.

A DIFFICULT problem has been attacked by Mr. E. A. Martin in this book. He defines a dew-pond as "one situated on the higher grounds, generally on the chalk downs of the south of England, which retains by some means or other a supply of water throughout all but the most prolonged droughts, whilst those ponds situated on the lower lands have consistently dried up." With the aid of continuous observation, and a grant from the Royal Society for experimental purposes, he has been able to throw much light on these curious ponds. He shows that "dew-pond" is a misnomer, for dew is quite insufficient to make up for loss by evaporation; and he inclines to the use of the term "mist-pond" as better explaining their origin. However, "dew-pond" is in common use, and when farmers speak of dew they include the condensation of mist and cloud also.

The author suggests that the small crystals of sodium chloride, found in sea air, have acted "as nuclei of condensation when the night-mists form on the downs, and as the mists blow up in the early morning from the sea they pass across the pond-depressions and are deposited in quantities there." Certainly it is to the morning mists drifting in from the sea that the replenishment of these ponds is mainly due. We would direct particular attention to some of the observations, in which are given actual measurements of the amount thus deposited. It is noticeable also what a large part is played by rushes or other vegetation in increasing the deposition. However, aspect, slope of ground, and other things all play their part, and great care is needed in the selection of a site.

We recommend this book to the notice of engineers and others who have to do with hilly regions where rain is deficient, but where heavy mists are common, as, for instance, the Pacific slopes of the Andes.

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.]*

Resonance of Sodium Vapour in a Magnetic Field.

It is well known from the observations of Wiedmann and Schmidt, Wood, Dunoyer, and others that dilute sodium vapour contained in a glass bulb emits resonance radiation when a soda flame is focussed upon it. During the last few days I have examined the effect on the resonance radiation of putting the resonating vapour in a magnetic field.

If the exciting flame contains very little soda, the resonance radiation is diminished by the field.

If, on the other hand, the flame is rich in soda, the field greatly increases the resonance radiation.

It is too early to put forward more than a tentative suggestion towards the explanation of these effects. Each sodium line emitted by the resonating vapour is broadened by the Zeeman effect. The flame poor in salt gives a narrow exciting line, and magnetic broadening throws a part of the resonating line off the exciting line, thus diminishing the light.

Adding more salt to the flame makes each exciting line broader, and (it is provisionally assumed) reverses the middle of it. Thus magnetic broadening of the resonance line tends to bring the brightest parts of the exciting line into action, and increases the light.

It may be remarked that with an intermediate condition of the flame a moderate field would produce the kind of effect last referred to, while a very strong field would separate the side components so far as to throw them beyond the limits of the exciting line. An effect of this kind has been observed, though unfortunately the condition of the exciting flame at the time was not noted. The current was switched on, and as the field increased (this takes a perceptible time) the resonance radiation increased and then diminished again. On turning the current off, the light again passed through a maximum. The greatest strength of field used in this experiment was about 14,000 units. Brightening can be distinctly observed with 1000 units, when a well-salted flame is used.

I have not been able to find that any previous observations have been made on the resonance of sodium vapour in a magnetic field. Observations were made on mercury vapour by Malinowski (*Phys. Zeits.*, September, 1913). The present experiments were suggested by some made in this laboratory by Mr. F. S. Philipps on mercury vapour (see NATURE, December 4, 1913). His observations were independent of Malinowski's.

R. J. STRUTT.

Imperial College, South Kensington, March 9.

The Spectra of Hydrogen and Helium.

DR. BOHR's letter in NATURE of March 4, although giving an interesting discussion of some aspects of this problem, does not meet the particular point which my letter was designed to raise. This point was solely that since combination series must be expected from the "4686" series in any circumstances, and since the lines so calculated occupy the positions in which lines have been found by Evans, they cannot be used to discriminate between theories of the origin of spectra, for we cannot prove that the observed lines are not these combination lines. It is true that Bohr's theory involves the combination principle, but so also does that of Ritz, who originated the principle.

My letter (NATURE, February 11, p. 642) took up this purely negative attitude, and was not intended as a criticism of the theory. It did not even advocate a hydrogen origin for the lines. Fowler's view, that the "4686" series is a 4N series analogous to that in magnesium, was, in fact, stated to have more evidence in its favour. Whether the origin be really hydrogen or helium is not actually relevant to my argument. Even if the origin is really helium, it was pointed out by Fowler in his Bakerian lecture that his results do not formally imply Bohr's theory. Since that time, the writer has published a proof that the theory cannot explain 4N series in general, for such elements as magnesium. It can only deal with helium, and the formal analogy between helium and magnesium would weaken, rather than strengthen, the theory.

The greater part of Dr. Bohr's letter does not bear on my original point, for he is seeking to discriminate between a hydrogen and helium origin, and between his view and Rydberg's, not directly by Evans's experiments, but by other considerations. At the risk of going further from the point at issue, I feel that some remarks on these considerations are necessary.

The references to Rau's experiments on voltages necessary to produce series are interesting, and if they have been interpreted correctly—there is some doubt of this—they show that the chemical origins of the series are those stated by Dr. Bohr, and by Stark and others. They show also that the electrons in Bohr's model atoms have the proper angular momenta. There are other reasons for believing that the relation of the atom to Planck's h is contained in the angular momenta, and such atoms were treated by the writer some years ago, but with a different kind of emission. Nevertheless, Rau's experiments have nothing to do with the mechanism of spectral production, and cannot support any theory of the mechanism of radiation. For the radiation problem is quite superposed on any specification of the steady configurations of non-radiating atoms.

The remarks concerning Rydberg's view proceed throughout on the supposition that the usual constant μ—Rydberg's phase—is *zero* in these series. No such case is known elsewhere in the whole range of spectra. It is quite easy to fit the "4686" series into a formula exhibiting it as a principal series of hydrogen, if this constant μ is not arbitrarily chosen as zero. There are other arrangements of the disputed series as hydrogen series which are formally possible, but their description would occupy too much space here. A full account of the whole problem will be published shortly, so that I propose to discontinue the present discussion with this letter. Meanwhile a protest must be urged against Dr. Bohr's conviction that the spectrum of atomic hydrogen consists solely of the Balmer, Ritz, and Schumann series. For MM. Fabry and Buisson have shown that a very large number of lines in the "secondary" spectrum are due to atoms of hydrogen. A correct model of the hydrogen atom must account for more emission spectra than have yet been deduced by Bohr's theory. Finally, I must again state explicitly that my present purpose is not to call the theory into question. My only concern is to show that no decisive factor has yet entered, and that judgment between theories must at least be suspended for the present. The importance to physics in general of the whole question of spectral emission is so great that a hasty decision must not be made. And the fact remains that all the present experimental results are explicable in widely different ways. The test mentioned at the end of my previous letter still appears to be an obvious crucial one.

J. W. NICHOLSON.

University of London, King's College, March 5.

A Neglected Correction in Osmotics.

In the dynamic method of determining relative vapour pressures, air, initially dry, is passed first over the solution and then over the pure solvent. When it leaves the solution it has taken up a quantity of solvent vapour l_1; on leaving the solvent it contains a further quantity, $l_0 - l_1$. While working on aqueous solutions at 0° C., Mr. Hartley and I had realised that the air when over the solution expands by an amount represented by the vapour pressure of the solution, similarly a further expansion takes places over the solvent, but as this further expansion is only that due to the difference of vapour pressures of the two liquids—say 1/10th of 4 mm. Hg—we had assumed that this small quantity was negligible in comparison with the total pressure.

Dr. C. V. Burton, of my laboratory, has pointed out to me that this assumption is not justified when osmotic pressures are to be calculated from the observed results. His discussion of the necessary correction is as follows. Let B be the barometric pressure and V the volume of air (measured when dry) passed through the system. The air in contact with the solution has a partial pressure of $B - \pi_\pi$, and the volume now occupied by it is increased to $VB/(B - \pi_\pi)$. Similarly, on leaving the solvent the volume has become $VB/(B - \pi_0)$. If ρ_1 and ρ_0 are the densities of the vapour in equilibrium with the solution and solvent respectively, the masses l_1 and l_0 are $\rho_1 VB/(B - \pi_\pi$ and $\rho_0 VB/(B - \pi_0)$.

Assuming that Boyle's law holds good for the vapour up to π_0, with sufficient accuracy for the purpose of the correction, we can replace π_π by $\pi_0 \rho_1/\rho_0$. We have then what amounts to a simple equation in ρ_0/ρ_1; its solution is $\rho_0/\rho_1 = l_0/l_1 - \frac{\pi_0}{B}\left(\frac{l_0}{l_1} - 1\right)$.

In the value deduced for the osmotic pressure, $\log_e(\rho_0/\rho_1)$, enters as a factor, and the corrected value of this factor is $\log_e(l_0/l_1) - \log_e\left[\frac{\pi_0}{B}\left(\frac{l_0}{l_1} - 1\right)\right]$.

The correction for a solution at 0° C., the osmotic pressure of which is 132 atmos., is −0·84 atmos., and for one the osmotic pressure of which is 41 atmos. it is −0·26 atmos.

BERKELEY.

Foxcombe near Oxford.

Chemistry and Industry.

In his admirable article in NATURE of February 18 under the above heading, Prof. Jocelyn Thorpe dealt in a very concise manner with the grave difficulty which must seriously hamper all the present efforts to establish chemical industries in this country in successful competition with Germany. Particularly his remarks that the scientific worker has found by sad experience that little financial profit accrues to him even though he goes to the trouble of obtaining patent protection for his discovery, are of interest.

In this country, when an inventor applies for patent protection, a novelty search is made by the Patent Office in respect of his invention, solely among British patent specifications published before the date of his application during a period of fifty years. In contradistinction thereto the examiners at the German Patent Office investigate all printed publications of the last one hundred years prior to the date of such application. These publications include not only German patent specifications, but patent specifications and text-books of every country in the world. The applicant's attention is directed to any prior publication or text-book dealing not only with the particular subject but containing even remote suggestions that may lead up to that particular discovery.

Now, while this somewhat gigantic problem of the German Patent Office cannot in all cases be efficient and free from fallacy, it is, nevertheless, quite clear that the result of such a search must in a large number of cases be of greater value than that of the limited search carried out by the British Patent Office. In this manner, therefore, the inventor, if his discovery is found novel and patentable in Germany, has not only the satisfaction of having his invention tested quasi from an international point of view, but what is more valuable to him, he has his attention directed to knowledge existing and discoveries made also outside his own country.

Due to this wide scope of the official search, apart from other stringent considerations connected therewith, fewer patents are, of course, granted proportionately in Germany than are granted in this country, and it would, indeed, be interesting to examine how many of the discoveries for which patents have been granted in this country, for instance, in respect of aniline dyes, have, in fact, been protected also in Germany. A number of these British patents on which royalties are probably being paid, or will be paid in the near future, would, perhaps, not stand a test before our courts, since prior text-books or a prior foreign specification may be relied upon in an action before a British Court, while the Comptroller-General of Patents has no right to consider such publications before granting a patent.

I have heard it argued that our limited search was good enough, because if there was anything worth patenting anywhere, it would certainly be patented in this country. I venture to suggest that this is as much an antiquated idea as prevailed, until this war opened our eyes to the present industrial situation, with regard to the industrial supremacy of these islands shortly after the time when Section 27 of the Patents and Designs Act of 1907 was called into being. In this connection it is interesting to recall a famous phrase uttered by Mr. Justice Parker (now Lord Parker) in his decision in the matter of the revocation of Hatschek's patents, Nos. 6455 of 1900 and 22,139 of 1900, viz.:—"However great may be one's belief in the industrial supremacy of the inhabitants of these islands, it would at least be somewhat arrogant to assert that wherever the manufacture of a patented article in the United Kingdom is less than one-half of the total manufacture of the whole world, there arises a presumption that British trade has not had fair play."

The decision involved a matter of great importance to patentees, manufacturers, and British traders, and it was justly stated that the whole industrial world was anxiously awaiting the dictum on that famous section of the Act.

The greatest anxiety, of course, prevailed in Germany, and this was natural in view of the many British patents taken out by German chemists and chemical concerns for the purpose of blocking the industry in this country rather than of developing it.

Now, why has that section failed to do that which it was actually framed for? To my mind there are several important reasons. The average manufacturer does not possess the knowledge that chemical manufacture cannot in these times be carried on without his close co-operation with highly trained chemists, and, true to old-established tradition, he is prejudiced to any such co-operation. Further, he is constantly faced by the danger of infringing existing British patents, and even though he may be aware that the patents blocking his way are mere "paper" patents and that he has every reasonable hope to succeed in an action for infringement or revocation thereof, the exceedingly high cost at present connected with any action must have an important effect on his hesitative attitude, and largely accounts also for the perpetual success of those whose business it is to defy the section and to maintain their "unworked" patents to the detriment of the British industry.

JUSTIN E. POLLAK.

London, March 4.

Measurements of Medieval English Femora.

PROF. KARL PEARSON'S criticisms are always welcome and stimulating to those strong enough to bear them though, since they are usually of the destructive variety, the fear of them undoubtedly prevents a good deal of work which would add to our knowledge being published. Let me deal, for instance, with the following criticism. "Looking at Dr. Parsons's results I can but conclude that his sexing is based on a fallacy, and the dip he has created in the Rothwell femora between those with 45 and 47 mm. heads—the range of Dwight's doubtful sex—is due to conscious or unconscious selection of his material; out of the great masses of bones available at Rothwell (which should have occupied in measurement of many characters and in their adequate reduction the whole time of a man for four or five years)."

By "conscious selection of material" I can scarcely think that deliberate fraud is suggested—I do not indeed know what it really means; while unconscious selection I suppose is covered by inaccurate measurements or by the absence of bones of a certain size which ought, mathematically, to be there.

At any rate, the impression conveyed by the stricture is that, from an enormous available mass of material, I have deliberately or unfortunately picked out a small selection which would bear out some object which I wished to prove

It is almost inconceivable that Prof. Karl Pearson would have mentioned the "great masses of bones available" unless he really knew what he was talking about, so that we may safely assume that he has been to Rothwell and satisfied himself on this point.

I can only say that I have spent a great deal of time at Rothwell, and that I found considerable difficulty in picking out 300 measurable femurs, and this was particularly the case with the slighter bones which, owing to the damp, snapped like carrots when touched.

I can assure Prof. Pearson that every measurable bone which could be extricated was welcome, and none were rejected because their sizes did not suit.

As to four years of a man's whole time being needed for the research, I can only infer that Prof. Pearson thinks that there is unlimited measurable material at Rothwell, and that, if I could not give the time he thinks necessary, I had better have left it to some other man who could. These really are the words of the "mere mathematician" ignoring all practical details. Did not Prof. Pearson observe when he went to Rothwell that the bones were rotting with damp—exactly the opposite condition, by the bye, to his Naquada bones and that the farther he worked into the stack, for he must have done this or how would he otherwise have known about the "great masses of bones available"? the more sodden and useless the material became? As no one else showed the least sign of spending even four weeks in working at the Rothwell bones, I did what I could while I could, for if I had left it for another ten years the available material would have been much less. Incidentally, I advised the restacking of the heaps, so that air now gets among the bones, and they will not disintegrate so rapidly. There is another practical point, too, about which Prof. Pearson is silent; it is the fact that the ordinary anatomist has difficulty in getting unlimited measurements recorded, and my contribution of sixteen sets of measurements on nearly 300 bones was all I could fairly expect our journal to print for me at one time.

In other points I think that Prof. Pearson and I are in practical agreement. We agree that neither of us can sex femurs with accuracy (I find that in eighty-two attempts I made seven mistakes), but that, when we have sexed them to our individual taste, the average difference in results is a fraction of a millimetre. We both agree that the head measurement alone is often liable to mislead, and that a series of secondary sexual tests of graded value are needed. These I have attempted to provide in a paper which will appear shortly, and of which I will not fail to send Prof. Pearson a copy.

Above all, I am glad to see that he tacitly agrees with me about the Rothwell bones being medieval, probably of the fourteenth and adjacent centuries.

F. G. PARSONS.

St. Thomas's Hospital, S.E.

The Green Flash.

PROF. PORTER'S interesting letter (NATURE, February 18, p. 672) on this subject must be my excuse for sending a summary of my own experience during the last eighteen years in which I have observed the flash more than a hundred times, and in no single case did I find anything not explainable by atmospheric dispersion, nor anything that could be put down as a subjective or complementary after-image.

I may add that I have observed with the naked eye, with an opera-glass (power 3), with binoculars (power 9), and with a telescope (power 100).

Whenever on a clear day a low sun is observed through a telescope, the upper limb appears bordered with a marine, *i.e.*, blue-green, fringe, the lower with an orange-red fringe, the side-limbs are unaltered. (The telescope should have a solar diagonal and other means of reducing the brightness of the sun.)

The marine upper fringe develops ultimately into the green flash, the blue element weakening as the sun descends. I have watched this change with the telescope, and it is perfectly continuous.

Again, if the sun descends behind a low cloud, parallel to the horizon, but with a clear space between, the base of the sun, just as it becomes visible, shows the red flash. I have seen this only thrice, as the necessary conditions are obviously seldom satisfied. The red flash seems inexplicable save by dispersion.

Under favourable conditions at sunset, as the upper segment of a yellow sun gradually diminishes, the right and left corners of the segment become green; this colour gradually spreads inwards, becoming marine, until finally the last tip of the sun may appear almost greenish-blue, and just as the sun has sunk, a very faint wisp of blue light is glimpsed directly above the point of disappearance. One friend even records a violet wisp.

But when the sun is orange the blue is replaced by green, and when the sun is really red no green flash at all is seen, the atmosphere cutting off the green as well as the blue rays. To see these changes it is desirable to use a power of 8 or 9.

Prof. Barnard, writing to me some years ago, said he preferred the title, "blue flash," as in sunsets seen over the Pacific from the Lick Observatory the final flash was usually blue. Doubtless this is due to clear atmosphere.

It is well known that at sunrise, when no exciting colour can be present, the flash has been seen, sometimes green, sometimes blue.

In the 1906 volume of *Symons's Meteorological*

Magazine appears correspondence on this subject by Dr. Rambaut, myself, and others, and the editor, Dr. Mill, in summing up the matter, decided strongly in favour of the dispersion theory. Capt. Carpenter, R.N., whose numerous observations appear in the *British Astron. Assoc. Journal*, holds the same view.

It is quite true that, if I look steadily at a bright red sun, and then close my eyes, I see a green after-image, but this is just what the observer of the green flash should not do. He should avoid looking at the sun when it is bright, and should wait until it is so low that the eye can easily bear the light—should wait, in fact, until only a very small segment is visible. As before stated, with a really red sun the flash fails to appear, so far as my experience goes. If proper precautions are taken I do not think any appreciable after-image will be present.

I may point out that the nature of the horizon, provided it is clean-cut and low down, makes but little difference. It may be of cloud, land, or water, and, of course, the last is the best. My experience relates to all three.

But few persons appear to have used a telescope for observing the flash. If those who have not done so would observe a low sun with a power of, say, 100, I think that they would be convinced that the true cause was atmospheric dispersion.

The real mystery about the flash is that it so often fails to appear, when apparently all conditions seem favourable. I have not yet found any explanation of this, but I am inclined to the opinion that at a clear sunset the flash could always be seen if a telescope were available, though it might be too feeble for the naked eye, for a telescope invariably reveals the upper green fringe when the sun is low. The telescope, of course, was achromatic, and showed no colour with a high sun. To the Journal of the B.A.A., to that of the Leeds Astron. Society, and to the *English Mechanic* I have contributed very numerous notes on this subject, but references to them would occupy too much of your valuable space. C. T. WHITMELL.

Invermay, Hyde Park, Leeds, February 22.

The Prices of Chemicals.

I HAVE had the same experience as "S. P." Since my letter of February 18 I have been able to purchase dulcite at 60*s*. an ounce from a firm of dealers in chemicals other than the one to which I referred. I cannot admit, therefore, that my complaint was unjustifiable. J. J.

University of Liverpool, March 2.

THROUGH SIBERIA.[1]

THIS book is the diary of a very interesting journey accomplished by the author in the course of the autumn of 1913. In fact, it describes four different journeys: one from Tromsö, *via* the Kara Sea, to the mouth of the Yenisei; then up the Yenisei to Krasnoyársk; next by rail across Transbaikalia and Manchuria to Vladivostók on the Pacific: and from this port to Petrográd, by the Usuri and the new Amur railway and the main Trans-Siberian line. A remarkable feature of this journey, during which more than 16,000 miles were covered, is that it was accomplished in less than three months, from August 5, when the party started from Tromsö, to October 27, when Dr. Nansen reached Petrográd.

We cannot expect to find detailed descriptions of the different portions of the immense continent thus rapidly crossed; but the book throughout has the greatest interest, owing to the human element it contains, and the unexpected glimpses it gives of the Canada of the East, with its wonderful development during the last fifteen years. In addition, it is illustrated by more than 160 beautiful photographs, taken by the author himself, most of which are worth pages of descriptions. The ethnographical remarks about the northern natives, whose encampments, or boats, Dr. Nansen always found time to visit, especially about the remaining members of that curious, once numerous, nation, the Yenisei Ostyáks, will be read with a special interest; while the photographs, as may be seen from the two accompanying specimens, give a clear idea of the ethnographical types of the different native tribes.

The really difficult part of the journey, from Tromsö to the mouth of the Yenisei, was made on the steamer *Correct*, with the experienced pilot Capt. Johannsen, without meeting with serious difficulties. There was a good deal of ice in the Kara Strait, and especially further east, so that the *Correct* had to enter the Kara Bay in order to follow the narrow, more or less ice-free channel close to the coast of the Yalmal peninsula. There was only one dangerous accident, when the steamer stuck on a mud bank close by the Devil's Island; but otherwise the journey was quite successful, and it took only eighteen days from the day the steamer entered the Kara Strait to the day it reached the port at Nosónovskiye Islands, in the Yenisei, under the 71st degree of latitude.

Once more the practicability of the northern route to Siberia was thus demonstrated. But it must be said that the conditions of ice along the northern coast of Siberia show great variations in different years, and in 1913 they certainly were by far not so favourable as they were in the years 1870–1871 and 1875–1878. A very valuable appendix, where the average summer temperatures on the shores of the Kara Sea and the conditions of ice in that sea are given for the last forty-one years, shows that while this passage was remarkably free from ice in the years named, as well as in 1890, 1897, 1900, 1901, and 1904, the conditions were not favourable for navigation in 1883, 1884, 1888, 1911, and 1913, unfavourable in 1895 and 1902, and most unfavourable in 1903 and 1912.

Still, Dr. Nansen is certain that the northern route may become a regular line of traffic if certain measures are taken. During his journey up the Yenisei, and later on along the Trans-Siberian railway, he had full opportunities to discuss such measures with M. Vostrótin, a Russian merchant and member of the Duma who has great knowledge of the Siberian north, and also made the journey on the *Correct*, and

[1] "Through Siberia, the Land of the Future." By Dr. F. Nansen. Translated by A. G. Chater. Pp. xvi+478. (London: W. Heinemann 1914.) Price 15*s*. net.

M. Wourtzel, the head of the traffic on the Siberian railway.

"We had," Dr. Nansen writes, "great deliberations in the saloon [of the train] as to how the trade route between Norway and the Yenisei could be best secured, and what were the first steps to be taken to this end. We discussed the best arrangement of wireless stations, the dispatch of motor sloops to investigate the extent of the ice in the Kara Sea, how aeroplanes might be used for constantly reconnoitring the ice-conditions of the sea, in connection with the wireless stations, and so on. The construction of an efficient harbour for discharging and loading in the northern part of the Yenisei and the transport up and down the river were discussed with Vostrótin, who has these questions at his fingers' ends. By degrees a whole programme was drawn up under the shrewd guidance of Wourtzel."

Group of Yenisei-Ostyáks. From "Through Siberia." By Dr F. Nansen. (London: W. Heinemann.)
(The figures in the background, left and right, are Russians.)

The journey up the Yenisei to the town Yeniseisk, made in a little motor steamer, *Omul*, offered Dr. Nansen the opportunity of making many fine remarks about a variety of subjects—Baer's law of excavation of the right banks of rivers; the first appearance of larches; the exiles scattered even within the Arctic circle and living in tiny primitive huts, the first appearance of agriculture and cattle-breeding, and so on. The rapid change on this journey, from the endless treeless *tundra* to the thick forests region, the gradual growth of the clusters of "snug, low timber buildings," into villages, and further south into towns, and the transition from the isolated native huts to Krasnoyársk, with its gilded cathedral, public park, museum, schools, and electric light in the streets—all the town profusely illuminated to welcome the Norwegian guest—all this, most sympathetically told by Nansen, is fascinating reading.

At Krasnoyársk Dr. Nansen took the luxurious eastern train which brought him in four days, from September 29 to October 4, to Vladivostók on the Pacific. Notwithstanding the rapidity of this journey, we still find in Dr. Nansen's book very interesting remarks about the condition of Siberia, the causes of its slow colonisation, and the rapid strides it has made since the Manchurian war.

Winter was rapidly setting in, and next day Dr. Nansen had already begun his return journey—this time on the railway which runs down the valley of the Usuri to the new town of Khabaróvsk, which I knew fifty years ago as a village of a score of houses. The great railway which is now built by the Russian Government along the left bank of the Amur had not yet reached this new capital of the Lower Amur region. An immense bridge, 7827 ft. long, on nineteen piles, is being built below Khabaróvsk across the Amur; and this bridge, as well as the lowlands on the left bank, representing an immense swamp for some 200 or 300 miles, often inundated during the monsoon rains, offer great difficulties to the engineers. The journey across this marshy region, as well as the crossing of the Little Khingán, were made by Dr. Nansen, partly in horse carriages, partly in trolleys run along temporary rails, and partly in a motor-car, until he reached, on the Zéya plain, about 420 miles from Khabaróvsk, a station where he could take the direct train to Petrográd. This station, from which Dr. Nansen could now travel by rail all the way to Petrográd, with but one or two interruptions at unfinished bridges, received from the local engineers the name of "Nansen's."

On October 18 Nansen was at Chitá, where he joined the Eastern Express. He passed Irkútsk at night, without stopping; six days later he was in the Urals, and on October 27 he reached Petrográd; and yet, notwithstanding the rapidity of the journey, his observations and remarks about Siberia, "the land of the future," "Russia in the East," and "The Yellow Question," and so on, are both valuable and interesting.

The book is richly produced, with numerous excellent reproductions of Dr. Nansen's photographs, and with three maps—one of the Kara Sea and adjoining lands, and two of Siberia. The transcription of Russian names, both in the text and on the maps, is quite correct, with the exception of a very few words, in which the German spelling has been followed (Tas, Seya, Syriansky, instead of Taz, Zeya, Zyriansky).

P. KROPOTKIN.

Men and women of the Yuraks and Yenisei Samoyedes. From "Through Siberia." By Dr. F. Nansen. (London: W. Heinemann.)

A BIOLOGICAL PUZZLE.[1]

DR. BRUN, of Zürich, has done a fine piece of work in devising an elaborate and ingenious series of experiments which enable us to come to a decision among the rival theories of way-finding among ants. Let us first illustrate the facts. If we pick up one of the higher ants from an ant-road, turn it about in a box, and then empty it out again near the place of its capture, it makes no mistake in hurrying homewards. When an ant goes off alone on an exploring adventure, it often keeps persistently in one general direction, in spite of many divagations to one side or the other, and when it turns its face homewards, it does not usually retrace its steps, but pursues a parallel course until it comes near the nest. If a higher ant, such as *Formica rufa,* be gently but firmly induced to travel on a path chosen for it and not by it, it makes straight for home when freed from coercion. It may run along a line which is the hypotenuse of the triangle the other two sides of which it was compelled to follow, or it may complete a polygonal figure and reach the nest. If members of such species as *Formica rufa* and *F. sanguinea* be lifted up and carried some distance and put down in hunting ground which they have

[1] "Die Raumorientierung der Ameisen und das Orientierungsproblem im allgemeinen. Eine kritisch-experimentelle Studie; zugleich ein Beitrag zur Theorie der Mneme." By Dr Rudolf Brun. Pp. viii+234+51 figs. (Jena: Gustav Fischer, 1914.) Price 6 marks.

not visited for a fortnight, they will return home, quickly, confidently, and by the shortest way.

These are four illustrative facts out of many, and the question is how they are to be interpreted. Some authorities still believe that there is no getting past the assumption of a non-analysable sense of direction, such as the Martian of Du Maurier's novel had of the North Pole. Others have swung to the opposite extreme of taking too simple a view, and maintain that it is altogether a question of scent: ants, like dogs, living in a smell-world. Others again lay too heavy a burden on muscle-memory, and others on visual impressions gathered by the way. Dr. Brun shows clearly, we think, that the power of way-finding is usually a composite product, and that there is no mysterious sense of direction.

Of course, there are ants and ants, and there is no doubt that the scent of the nest, of the food, and of the pupæ sometimes counts for much. If two adjacent sections of a pre-arranged ant-road be lifted and interchanged, the travellers go on just as they were doing; but if a section of the road—say a zinc plate—be lifted and replaced with its ends reversed, the ants seem to be perplexed at the boundaries, and there may be a temporary block. Facts of this sort have given rise to over-ingenious theories of polarised scent, of positive and negative scent, and so forth. This much seems clear, that the nest-smell gets fainter in proportion to the distance from home, and that the food-smell increases as the source of supply is approached; and it is very instructive to find that if an ant of one of the olfactory species be transported and placed in the middle of one of the ant-roads, it does not go home right away, but takes a tentative run first in the one direction and then in the other. In some genera, however, such as Formica, smell counts for little, and the obliteration of the scent by brushing the road or pegging down a spread-out newspaper does not disturb the homing. In connection with smell, it may be noted that the seat of the olfactory sense is in the tips of the mobile antennæ, where tactility is also located, so that tactile and olfactory impressions are closely combined.

To many ants the illumination is much more important than scent, as Lord Avebury proved long ago. He got his ants to make a path across a wooden disc, concentric segments of which could be rotated, and found that if he turned a ring so that an ant on its journey was made to face the wrong way, it righted itself and proceeded in the old direction. But this was not the case when he made the experiment in uniform shade, or when he shifted the light at the same time as he rotated a segment of disc. One of Brun's experiments with a species of Lasius is very instructive. It was marching with the sun directly in its eyes, when the experimenter put an extinguisher over it, and kept it prisoner from 3 to 5 p.m. When it was set free at five o'clock, it turned its back on the position which the sun had reached, moving through 30°, and set off in a straight line homewards, eventually turning sharply to the left to reach its original starting-point. Numerous experiments confirm the view that the direction of the light serves as a compass. When Santschi shut off the sun with a large shade and made a false sun by means of a mirror, he got the ants, even on one of their main roads, to march in a direction either at right angles to the original one, or opposite to it, according to the position of the mirror. If, in the absence of sunlight, there be equal bipolar illumination of a given area, there is in many species no orientation.

From waxing and waning scent and from differential illumination, ants seem to build up associations, but this is not all. There is evidence in some cases of a memory of muscular movements, especially of the distance traversed, as if the ant kept its eye on a pedometer. There is something very interesting, too, in the phenomenon technically known as Turner's curves. A solitary ant that has travelled successfully from a considerable distance reaches a point quite near the nest; but instead of going on confidently, it stops as if perplexed. In many instances—80 per cent. in *Cataglyphis bicolor*—it proceeds to describe concentric curves, it may be for 5–15 minutes, and gradually draws near to the door of its home. Is it seeking for a sign, which might be a shining stone among the sand, or a scent, or the faint stridulation of one of its kin? Is it pursuing a trial and error method, very willing to be helped by any hint or combination of hints?

In some cases, *e.g.*, *Formica rufa*, Brun has proved a baræsthesia, or feeling of gravity. A table was gently tilted, with the nest at the foot of the slope; a feast of honey was placed in the centre; the ants climbed straight up and straight down again. But if, while an ant was supping honey, the table was gently tilted in the opposite direction, so that the way to the nest was up-hill, the ant persisted in going down-hill as before—away from, not towards, home. Among the highest ants Brun finds distinct evidence of definite local memory, based on visual, topographical, and topochemical data, and lasting for two or three weeks at least. And only thus can we understand the confidence with which one of these creatures, transported to a distant part of its range, will make for home. There are ants which trust mostly to scent, and others which are largely guided by the direction of light, but for the higher ants the orientation is a complicated process, the outcome of the registration of manifold imprints received from the outer world—imprints relating to the quantity and quality of scents, the general direction of light, the illumination of particular objects, the slope of the ground, the feel of things, the distance travelled, the turns of the road, the direction of the wind, and even, perhaps, sounds. Individual ants hereditarily endowed with great sensitiveness, hereditarily attuned to receive certain kinds of tidings, serve an apprenticeship in the establishment of associations and reach a degree of perfection probably unsurpassed. Such is Dr. Brun's general position, which he defends with strong experimental evidence. There are still to be found old-fashioned fishermen who have attained within a certain range to a wonderful seamanship of an empirical sort; they have built up a body of associations from wind and from wave, from the sky and the "feel" of the sea, and they are seldom far out in finding their way home. And so it is with the higher ants, except that they work even more exclusively from an instinctive basis.

It must be remembered that the orientation power of ants does not stand magically alone. Even brainless animals adjust their body in a position of physiological equilibrium in relation to a stimulus of light or warmth or gravity—a static orientation. When there is direction of locomotion in relation to an external stimulus, we speak of dynamic orientation. This dynamic orientation may be direct or indirect. It is direct when the stimulus or goal is within the range of immediate sense-perception, and it must be noted that for ants this range is only about a yard. Of this locomotor orientation there are various grades—tropistic, reflex, instinctive, and acquired, the first three expressing a hereditary predisposition, the fourth expressing the results of the individual's own learning. On a higher level is indirect orientation, where the goal is beyond the range of direct sensory perception. A complex of imprints or memories, corresponding to the goal, functions in the animal's sensorium, and forms the unifying centre of a whole series of imprints of the environment of the goal. What leads the creature on from step to step—often quickly and, so to speak, unquestioningly, if no contradictory interruption occurs—is the recognition of localised stimuli corresponding to those of the unified reference series. The orientation implies a chain of recognitions, and the recognitions imply a registration of individual experiences. Without using Brun's somewhat forbidding mnemic terminology, we cannot do justice to his carefully worked-out theory, but we have indicated its general nature. It is essentially what may be called psychobiological, for he thinks of the organism as a historic being that trades with time, that enregisters imprints, and that has its past living in its present, as Bergson has accustomed us to say. These imprints, which the individual ant selectively accumulates, are not like sheets filed in a portfolio of reference; they are interpenetrated with and kept alive by their meaning for the actual everyday life.

PROF. JAMES GEIKIE, F.R.S.

BY the death of Prof. James Geikie, Edinburgh and its university have been deprived of one of the most prominent of its men of science, and geology has lost a distinguished investigator and successful teacher. The son of J. S. Geikie, of Edinburgh, whose literary talent found expression in a number of popular Scottish songs, the subject of this notice was educated at the high school and university of his native city, and in 1861, when only twenty-two years of age, received an appointment upon the Geological Survey of Scotland, a service in which his elder brother, Archibald, had already been engaged for five years. James Geikie's work as a surveyor lay chiefly in the south-west of Scotland, and in 1869 he was promoted to be a district surveyor; his studies seem to have been more particularly attracted, from a very early date, to the post-tertiary deposits, and in various papers in the scientific journals, as well as in the official memoirs of the survey, he published the results of his observations and his conclusions based upon them. Early in his career, James Geikie had become a great admirer and warm friend of Andrew Ramsay, then director of the English Geological Survey, and Ramsay's theoretical views and speculative suggestions found a stout supporter in the young Edinburgh geologist. In 1876 the Colonial Office requested Ramsay to proceed to Gibraltar in order to report on the important question of its water-supply, and James Geikie was chosen to accompany and assist him. In addition to the valuable report made to the Government, the two geologists were able to contribute to scientific journals memoirs dealing with the geology of Gibraltar, and especially with the superficial and cavern-deposits, and their bearing on the history of the Mediterranean in post-tertiary times.

In 1874 James Geikie had already published his conclusions concerning the history of the Glacial period in Britain in his well-known work, "The Great Ice Age," which has passed through three editions; and in 1881, after devoting his vacations to travel on both sides of the Atlantic, he extended the bearings of his views on the subject by the publication of his "Prehistoric Europe."

In the following year, however, James Geikie entered upon a new field of labour. The appointment of his elder brother to the directorship of the Survey necessitated his vacation of the Murchison professorship of geology at Edinburgh, and James Geikie received the appointment, resigning his position on the Survey. During his energetic and successful work of teaching, carried on for more than thirty years, he published a number of very valuable educational books: "Outlines of Geology," of which four editions were called for; "Fragments of Earth Lore"; "Earth Sculpture," two editions; and "Structural and Field Geology," three editions. His labours were not by any means limited to the special subject of his studies; he was one of the founders of the Royal Scottish Geographical Society, acting as editor of its journal, and for a time as president of the society. He was also for many years dean of the faculty of science in Edinburgh University. In 1875 he was elected a fellow of the Royal Society, and in 1889 received the Murchison medal of the Geological Society, while he was a member and correspondent of many scientific societies at home and abroad.

It was not only in his numerous scientific writings that James Geikie's hereditary literary instincts were exhibited, for he published in 1887 a series of translations from the German, "Songs and Lyrics by Heinrich Heine, etc." His frank manner and *bonhomie* won him many friends, and we may well believe that, though an ardent golfer, like so many other Scotchmen, he gave expression to the sentiment ascribed to him that he found a still more pleasant means of recreation in "loafing in pleasant places with a congenial friend." J. W. J.

EMILE-HILAIRE AMAGAT.

BY the death of M. Emile-Hilaire Amagat at his country estate at Saint Satur in the department of Cher, France loses one of her most distinguished physicists. Born in 1840, he held several minor teaching appointments before becoming professor at the Ecole Normal at Cluny. Here in 1867 he commenced his researches into the behaviour of gases under high pressures, which rapidly brought him into the front rank as an experimentalist. At Lyons, where he had become professor at the Catholic university, he utilised the tower of one of the churches as the site for a mercury manometer giving pressures up to 80 atmospheres, and in one of the coal mines of Saint Etienne constructed one up to 430 atmospheres. His observations on nitrogen at these pressures enabled him to use the nitrogen manometer in his experiments on other gases, on liquids and solids, and on the conditions of transition from one state to the other. By the help of a skilled mechanic he had himself trained, he was able to construct apparatus for observations at pressures up to 3000 atmospheres. His results, which appeared for the most part in the *Annales de Chimie et de Physique*, were summarised in memoirs of dates 1883 and 1893, and his curves showing the variation of the value of pv as p increases for hydrogen, nitrogen, and carbonic acid have been reproduced in standard text-books for the last twenty years.

In 1892 Amagat was elected an honorary member of the Literary and Philosophical Society of Manchester, and in 1897 a foreign member of the Royal Society of London. After going to Paris as examiner for admission into the Ecole Polytechnique, he was in 1902 elected member of the Académie des Sciences. In 1906 he was president of the French Physical Society, and soon after was elected one of its few honorary members. Although offered a professorship at the Ecole Polytechnique, he preferred his examinership, and continued to devote to research much of the leisure it allowed him. During the last few years his health kept him at his country house, and for several months before his death he was confined to his room. For a generation he had been one to whom younger men could appeal for advice and encouragement in their work, and many distinguished physicists of to-day recall with affection his kindliness, his sincerity, and his modesty. C. H. L.

NOTES.

THE prospectus of British Dyes (Limited), which was put before the public a few days ago, has evoked universal condemnation in the daily Press. As might perhaps have been anticipated, the board of directors does not include a single representative of science, whilst the directors appointed by the Government consist of a railway director and a civil engineer. This characteristic neglect of science, and its consequences, form the subject of two letters by Sir William Ramsay and Sir Henry Roscoe, published in Wednesday's *Times*. Sir William Ramsay gives numerous instances to show that scientific chemists *must* form an important part of the directorate if the scheme is to be a success. The Castner Kellner process has on its board Sir Henry Roscoe and Dr. Beilby. The ammonia-soda process, originally patented by Dyer and Hemming, was successfully introduced and managed by the late Dr. Ludwig Mond. The paraffin industry was due to the late James Young, at one time an assistant of Prof. T. Graham. Perkin's and Spiller's names are associated with the early days of synthetic colours. These men were both pupils of Hofmann at the Royal College of Chemistry. The firm of Spencer, Chapman, and Messel, which has for many years manufactured sulphuric acid by the contact process, owes its inception and success to Dr. Messel. Turning to metallurgy, Lowthian Bell and Bessemer were scientific chemists first; successful manufacturers after. In short, it would be difficult to discover a successful chemical industry which has not been initiated and controlled by a chemist. Unless "British Dyes (Limited)" copies this precedent, there is little hope for it.

SIR HENRY ROSCOE, in the letter referred to above, points out that it is not the manufacture of the well-known colours of indigo, alizarin, or methyl blue which will bring financial and final success to British Dyes (Limited). The preparation of these articles—which, like all complicated chemical processes, requires both knowledge and great care—is on well-known lines. It is the new thing which makes a business success. "In the colour industry it is then the research chemist, and he alone, who can keep the flag flying, for he alone can bring forward new forces and create new developments. Capital cannot do it, business capacity cannot do it, but the brains, the imagination, the skill, and the knowledge of the research chemist can." Yet though this is the case, so far at least, the research chemist is to have no voice in the direction of affairs in the new colour company, but merely to be called in as an expert when, in the opinion of his business superiors, he can help them to solve some difficulty. If this plan is persisted in and the scientific chemist is not given a voice in the management "success is improbable, if not impossible."

THE Bakerian lecture of the Royal Society will be delivered on Thursday next, March 18, by Prof. W. H. Bragg, upon the subject of "X-rays and Crystals."

WE regret to see the announcement that Principal Sir James Donaldson, Vice-Chancellor of the University of St. Andrews, died on Tuesday night, March 9, at eighty-three years of age.

THE death is announced, in his sixty-fifth year, of Prof. H. W. L. Tanner, F.R.S., formerly professor of mathematics and astronomy at University College, Cardiff.

WE learn from the *Morning Post* that Jean Maspero, the son of Sir Gaston Maspero, the Egyptologist, was killed in the Argonne on February 18 while leading his section into action.

PROF. SAMUEL W. SHATTUCK, for forty-four years professor and comptroller of the University of Illinois, died at his home in Champaign on February 13. Since 1868, says *Science*, Prof. Shattuck served the University of Illinois. For thirty-seven years he was head of the department of mathematics and from 1873 to 1912 he looked after the business affairs of the University.

ON Tuesday next, March 16, Sir J. G. Frazer will begin a course of two lectures at the Royal Institution on the belief in immortality among the Polynesians; and on Thursday, March 18, Dr. Aubrey Strahan will commence a course of two lectures on London geology. The Friday evening discourse on March 19 will be delivered by Prof. G. H. Bryan, on the modern piano-player—scientific aspects, and on March 26 by Sir J. J. Thomson on experiments in slow kathode rays.

WE regret to announce the death on March 6, in his eighty-seventh year, of Lieut.-General J. F. Tennant, F.R.S., past-president of the Royal Astronomical Society. When a young man, Lieut.-General Tennant was assistant to the Trigonometrical Survey of India. He served as Government Astronomer of Madras in 1859, and was afterwards transferred to the Public Works Department as an executive engineer, first, in Burma, then in the Punjab, and later in Bengal. He made observations of the solar eclipses of 1867–68 and 1871, and was in charge of those of the transit of Venus at Rurki and Lahore in 1876.

THE death is announced of Mr. Flaxman C. J. Spurrell, aged seventy-two. For many years he was interested in the geology of the Thames valley and co-operated with his father, the late Dr. Flaxman Spurrell, in collecting Pleistocene mammalia from the river-deposits at Crayford, Kent. In 1880 he described to the Geological Society his discovery at Crayford of a Palæolithic land-surface showing evidence of flint-implements in process of manufacture. The whole of the collection, both of mammalian remains and of flints, was presented to the British Museum (Natural History) in 1893 and 1895.

THE death is announced, at fifty-eight years of age, of Mr. William Willett, the promoter of the Daylight Saving Bill. The Bill proposed that clocks and other timepieces in Great Britain and Ireland should be put on an hour on the third Sunday in April of every year and put back again on the third Sunday in September. Mr. Willett was able to obtain support for this measure from many city corporations and town and district councils, in spite of the serious objections to it, but though the Bill was introduced into the House of Commons on two separate occasions it never reached the final stages. Mr. Willett was a fellow of the Royal Astronomical Society.

THE council of the British Association, in consultation with the local executive committee at Manchester, has decided that the annual meeting of the association shall be held in that city as arranged, in September next. Both the committee and the council have felt that it would be inexpedient under present conditions to offer an elaborate local hospitality in the form of social and other arrangements, which has been extended to the association on former occasions. The committee, however, expressed its desire that the long continuity of the yearly meetings should not be broken, and stated that it would "prefer that the meeting should be held although restricted to its more purely scientific functions."

THE War Office has just published the following table showing the distribution of the cases of typhoid which have occurred in the British Forces in the Field, between the categories of uninoculated, the fully inoculated, and the partially protected:—

	Cases	Deaths
Uninoculated	359	48
Fully inoculated within 2 years (two doses)	111	1
Partially protected (one dose) ...	136	1
Totals	606	50

LORD KITCHENER, Secretary of State for War; Dr. A. Strahan, F.R.S., director of the Geological Survey of Great Britain; and Prof. P. Vinogradoff, Corpus professor of jurisprudence at Oxford, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of three persons "of distinguished eminence in science, literature, the arts, or for public services."

WE learn that no fewer than thirty-seven members of the established staff of the Natural History Museum are at present serving with the naval or military forces, about half of them having joined their units at the front. Among these are Capt. E. E. Austen, who has for many years had charge of the Diptera in the museum; Lieut. C. Court Treatt, assistant in the bird-room, Mr. A. K. Totton, who was recently appointed to the invertebrate section of the department of zoology; Mr. H. F. Wernham, assistant in the department of botany; and Mr. W. N. Edwards, the newly appointed assistant for the study of fossil plants. In addition to the members of the established staff ten temporary assistants and forty-seven sons of the former class have joined the colours, while the museum has also furnished an efficient Red Cross Section and a platoon for the Volunteer Training Corps for Home Defence.

SOME few years ago the buildings of the Aquarium at Rothesay, which was for a time one of the well-known "sights" of the Clyde, were taken over by the Marquis of Bute. The buildings have, through the generosity of the Marquis, provided a local habitation for the Buteshire Natural History Society, of which Dr. J. N. Marshall is president, while they have also served to house a valuable and developing museum collection illustrative of the local fauna and flora. Lord Bute has now installed a small laboratory for biological research and provided the most necessary equipment, including a motor-boat. Mr. L. P. W. Renouf, of Trinity College, Cambridge, has been placed in charge, and as he is desirous of making the laboratory a thoroughly convenient centre for research work upon the wonderfully rich marine fauna and flora of the Clyde estuary, he will be grateful for the gift of books and pamphlets bearing upon marine zoology and botany. Any such gifts should be forwarded to the Bute Museum, Rothesay, N.B.

THE death is announced, in his seventieth year, of Dr. C. E. Bessey, professor of botany since 1884 at the University of Nebraska. For fourteen years previously he had held a similar post at the Iowa Agricultural College. From 1880 to 1897 he was botanical editor of the *American Naturalist*, and since 1897 he had been botanical editor of *Science*. Prof. Bessey had at various times occupied the presidential chair of the American Association for the Advancement of Science, of the Botanical Society of America, of the Society for the Promotion of Agricultural Science, of the American Microscopical Society, and of the natural science department of the National Education Association. He was the author of "The Phylogeny and Taxonomy of Angiosperms," "Plant Migration Studies," and "Outlines of Plant Phyla," as well as of several botanical text-books for schools.

WE referred in NATURE of February 4 (p. 622) to reports from a number of correspondents that the battle in the North Sea on January 24 was accompanied by much disturbance among pheasants in Lincolnshire, Yorkshire, and even in Cumberland. The disturbance was most noticeable between 9.45 and 10.30 a.m., that is, as we know from Sir David Beattie's report, at the time when the *Blücher* received its principal injuries before sinking. In woods near Burgh-le-Marsh in Lincolnshire, the guns were heard simultaneously with the crowing of the pheasants. Canon Rawnsley, who has collected many reports on the subject, infers that "the pheasant's ear is capable of receiving impressions from sound-waves that the human ear cannot respond to" (*Times*, February 22); but, in a later issue (March 6), Dr. Davison suggests that the disturbance might be caused by the sudden swaying of low trees and undergrowth during the passages of the air-waves. He directs attention to the fact (see NATURE, vol. lxii., pp. 377–9) that, during a naval review at Cherbourg on July 18, 1900, the reports were heard for 107 miles, while windows for another thirty miles were shaken by the inaudible air-waves.

ON Tuesday evening, March 9, Mr. George E. Brown, the editor of the *British Journal of Photography*, at a meeting of the Royal Photographic Society, described a method of colour photography that has recently been worked out at the Eastman Kodak Company's research laboratory at Rochester, N.Y. It is a two-colour method, and as blue is suppressed or represented in only a modified way, the process is not claimed to be suitable for other work than portraiture. The many fine examples shown prove that it gives excellent results, and that the lighter tones, such as those of flesh tints, white kid gloves, pearls, and so on, are particularly well rendered. The darker colours, such as the browns, are very rich, but in the absence of the original materials photographed, it is not possible to say how nearly the colours are imitated. The process consists in taking two negatives, one through a red and one through a green screen, developing and fixing them, then dissolving away the silver image, and staining the films, the red record green, and the green record red. The dyed plates are placed face to face (one is taken reversed to permit of this) and constitute the portrait. It has to be viewed as a transparency, those shown being adjusted in colour for incandescent electric lamps behind a diffusing ground-glass screen or its equivalent. If preferred, the original negatives may be kept as such, and ordinary positives prepared from them. These positives may then be made to furnish any number of negatives for conversion into colour portraits. We learn that the process has already been taken up enthusiastically by American portrait photographers.

THE most interesting contribution to vol. vii., part 4, of the Journal of the Gypsy Lore Society is the first part of an account translated from the Arabic of Father Anastas, the Carmelite, describing the Nawar or Gypsies of the East. The description of them is the reverse of complimentary: "swindling rogues, lewd adventurers, wicked nomads, heedless ruffians," preserving a language of their own but destitute of any religion—the last statement interesting if it be correct. They are believed to be a mixture of Indians, Persians, Kurds, Turks, and Tartars, with the off-scourings of the regions in which they have lived. Their name, Nawar, is, it is suggested a corruption of Lūr, the Persian wanderers who are noted for their skill in thieving, sleight-of-hand, and powers of witchcraft, and they may possibly be ultimately traced to the Indian peninsula. The author writes from personal knowledge of them, and he gives full references to the literature of the subject.

ACCORDING to the *Museum Journal* for September, 1914, a fine piece of art metal-work from the celebrated Dictæan Cave in Crete has found its way to the Philadelphia Museum. It is a unique bronze blade with incised designs, to which the nearest parallel is supplied by the inlaid daggers from the shaft graves at Mycenæ, but these are more elaborate in design and more beautiful in technique. The blade is 6 in. in length and is covered with a fine green patina. It probably belongs to the Late Minoan III. period. On one side a hunter is attacking a mighty boar with a spear, the jungle being indicated by a tuft of fern-like sprays between the sportsman and his victim. On the other side is represented the critical moment of an exciting bull fight, one bull clearly getting the worst of the encounter. Similar fern-like sprays on the quarters of one animal possibly represent the furry lines of his coat where the direction of the hair changes. The museum has also acquired a fine series of reproductions of the gems of Minoan and Mycenæan art—several swords and daggers, gold and silver cups from Mycenæ and Vaphio, faïence objects from the shrine of the serpent goddess at Knossos, and reproductions of some of the frescoes, including the famous cup-bearer.

AMONG the articles in the February number of the *American Naturalist* is one by Messrs. Castle and Fish on the black-and-tan rabbit and the significance of multiple allelomorphs, in which the origin of the breed is indicated.

IN vol. x., No. 7, of the University of California publications on archæology and ethnology, Mr. P. E. Goddard has collected a number of tales and legends of the Chilula tribe, a group of Indians now nearly extinct. The collection is a strange complex of primitive types of belief: animal tales, witchcraft, demonology, folk-medicine, and incidents of social life. It is well that the opportunity has been taken to place on record the language and folk beliefs of a people which in a few years it will be impossible to recover.

A PHOTOGRAPH of the European bison cow and calf in the Zoological Gardens is one of the features in the February number of *Wild Life*. Although this calf is the first of its kind born in the London establishment, cow-bison have produced offspring on more than one occasion in the Duke of Bedford's park at Woburn. In connection with a photograph of Canadian wild geese, Mr. S. J. Wigley states that the omission of these birds from the list of species protected in Alberta is a testimony to their alertness and cunning.

THE report of the Indian Museum for 1913–14 deals largely with last year's celebration of the centenary of that institution, of which a notice has already been published in our columns, and the inauguration of a series of public lectures. Much of the rest relates to administrative details and other matters of purely local interest; and attention has also been directed in NATURE to the biological survey of the Chilka Lake, which is discussed in the report under the heading of field-work. Among noteworthy additions to the zoological collections were specimens from the Chilka Lake, specimens received from the marine survey, mammal-skins sent by the Bombay Natural History Society, and a series of, chiefly fresh-water invertebrate, specimens from Kashmir.

NEW reptiles and amphibians from the Permo-Trias of South Africa are described by Mr. S. H. Haughton in vol. xii., part 2, of the Annals of the South African Museum. Very striking is a fine stegocephalian skull referred to the European genus Trematosaurus, under the name of *T. sobeyi*. A skull allied to Tapinocephalus is made the type of a new genus and species, with the designation *Struthiocephalus whaitsi;* and of two new therocephalians, one is regarded as entitled to represent a new generic type (Trochosaurus). Three dicynodonts are also described as new, in one of which it is shown that the bone in Lystrosaurus hitherto regarded as the exoccipital, really represents both that element and the paroccipital (opisthotic).

THE Journal of the Washington Academy of Sciences for January 19 (No. 2, of vol. v.) contains an interesting paper by Mr. H. S. Graves on the place of forestry among natural sciences. The importance of the forest as a distinct plant society and its connection with botany, plant geography, meteorology, sociology, and engineering is well put forward. In the same number Mr. P. C. Standley describes a new genus of Chenopodiaceæ from Arizona, under the name of Zuckia, which is most closely related to Atriplex.

PROF. H. H. W. PEARSON publishes an account of his observations on the internal temperatures of *Euphorbia virosa* and *Aloe dichotoma* in the Annals of the Bolus Herbarium, vol. i., part ii., 1914. The plants grow on the dry slopes of the Great Karasberg. The stem structure of the Euphorbia is remarkable from the large air cavities in the stem. The Euphorbia attains its maximum external temperature more rapidly than the Aloe, and temperatures as high as 51·5° C. were recorded when the black-bulb registered 65·8° C. On wounding, the temperature of the Euphorbia falls suddenly, and the fall is attributed to the expansion of the pith gases due to the withdrawal of latex. When a rubber pellicle has been formed over the wound by the exuded latex the fall in temperature ceases. In Aloe the lowering of temperature on wounding appears to be due to surface evaporation and the recovery in this case is slow, since there is no protective formation of rubber over the wound.

IN *Knowledge* for January Mr. L. Claremont describes the methods of ruby-mining in Burma, with the aid of a number of photographs, and of illustrations by Burmese artists. He deals also with the red spinels, or "balas rubies," of which a large example, presented to the Black Prince, occurs among the crown jewels of Great Britain. The possible sedimentary origin of the ruby-bearing limestone in Burma has been lately pointed out by Mr. T. H. D. La Touche (see NATURE, vol. xciv., p. 348).

THE *Revue Scientifique*, which continues its fifty-third volume in Paris, publishes (February 6) a lecture given in 1914 by Prof. Stanislas Meunier on "Le problème des montagnes." The author repeats his suggestion that earthquakes may be caused by the explosion of steam, when water-bearing blocks of the earth's crust slip down into regions of high temperature. He declines, however, to look forward, with Termier, to catastrophic displacements of the surface. We may note that the *Revue* invites records of Frenchmen destined for scientific careers, who have fallen, in heroic circumstances, in the present conflict. Two such obituaries are published in the number here referred to.

THE Meteorological Office with its recent *Weekly Weather Report* has issued a summary of temperature, rainfall, and duration of bright sunshine for the past winter, as comprised in the period for the thirteen weeks from November 29, 1914, to February 27, 1915. The temperature for the winter was in excess of the average over the whole of England, the greatest difference occurring in the east and south-east and in the midland counties, where the mean was approximately 2° warmer than the normal. In Scotland there was a deficiency of nearly 1°, and in Ireland the defect for the winter was about 1·5°. The duration of bright sunshine was not very different from the normal, the amount being slightly deficient in the eastern districts, whilst there was a slight excess of sunshine in the western districts. Excessive rains were recorded over the whole of the United Kingdom, the fall being heaviest over England, where the rains for the whole country were 196 per cent. of the average. In Ireland the rainfall was 152 per cent. of the average, and in Scotland 131 per cent. The greatest excess of rain occurred in the south-east of England, where the measurement, 17·19 in., was 248 per cent. of the normal, whilst in the east of England the record was 228 per cent. of the normal, and in the midland counties 196 per cent. The rainy days were in excess of the average over the entire kingdom, the excess being generally greatest in the English districts.

Symons's Meteorological Magazine for February gives the rainfall for January last at representative stations over the United Kingdom. The total at Camden Square was 4·12 in., which is 2·29 in. more than the average, and is 225 per cent. of the normal. This is the highest percentage of the average at any station given in the table, which, however, is only a tentative representation. Naturally there are many stations given with a larger rainfall, but the normals at these were larger. The map giving the Thames Valley rainfall for January, which in such times of flood as the present is of special interest, shows an area in the neighbourhood of Marlborough with a fall of more than 6 in., and fairly large areas are given with more than 5 in. The rainfall of 4·12 in. at Camden Square is said to be the greatest in January in the fifty-eight years' record, with the exception of January, 1877, when 4·74 in. was measured. Combining the records at Camden Square for the three months November, 1914, to January, 1915, the total measurement is 13·98 in., which is 56 per cent. of the annual average fall, and is 224 per cent. of the normal for the period. The rainfall for January is said to have been above the average over practically the whole of the British Isles, the excess being greatest in the south of England. On the Pennines 8 in. or more fell generally. A copy of a photograph is given showing the flooding of Salisbury Cathedral on January 5 and 6. In the neighbourhood the rainfall measured 16·86 in. from October 13 to December 31, and of this 2·93 in. fell in the last seven days of December, whilst an additional 2·06 in. fell in the first three days of January. The current number commences the fiftieth volume of the magazine.

THERE is a general belief that the paintings of old masters owe their success in some measure to secret processes or lost arts. A paper on the scientific aspects of this question is contributed by Dr. Maximilian Toch to the Journal of the Franklin Institute for January. Among other conclusions, the author points out that the painters only used a limited number of colours (madder being one) the permanency of which was well established, and that they avoided mixing those which were known to undergo chemical combination in each others' presence. As examples of scientific methods of detecting later day copies, some interesting examples are given. The use of zinc white instead of flake white, the presence of protoplasmic remains in the wood cells, and the transparency of the bitumen in the shadows are particular proofs that a picture is not a genuine antique. As regards deterioration, the author alludes to the serious effect of smoke and modern gas fumes, and further points out that while either light or darkness may bleach a picture, some that have been kept in the dark may be restored by placing them in bright sunlight. Finally, Dr. Toch condemns the style of modern painting, which substitutes the collapsible tube or palette knife for the brush, on the ground that the flakes of colour thus attached to the canvas will crack off and become detached. If, therefore, this method was ever used three hundred years ago, no traces of it would now be in existence.

DR. W. C. SABINE publishes an account of a recent lecture to the Franklin Institute on architectural acoustics in the Journal of the institute for January. The investigations referred largely to the lecture hall of Harvard University, in which an ordinary spoken word remained audible for about 5½ seconds. At first they were applied to determine the absorption only of a note of the pitch of violin C, but they have now been extended for three octaves in either sense. By introducing more and more cushions into the room a curve was plotted connecting the quantity of absorbing material with the duration of the sound, and was proved to be very approximately a rectangular hyperbola. Another curve shows that the absorption increases with the pitch. An interesting feature is the diagram showing the distribution of sound intensity in a room with a barrel-shaped ceiling, and though the curves look remarkably complicated, the author finds that it is easy to observe the maxima and points of zero intensity. In conclusion the author says: "While these several factors, reverberation, interference, and echo in an auditorium at all complicated are themselves complicated, nevertheless they are capable of an exact solution, or, at least of a solution as accurate as are the architect's plans in actual construction. It is entirely possible to calculate in advance of construction whether or not an auditorium will be good, and, if not, to determine the factors contributing to its poor acoustics and a method for their correction." It is a pity that these results are not generally applied, so as to prevent public halls being built in such a way that echoes make them almost useless.

M. HENRY LE CHATELIER has contributed an article on explosives to *La Nature* of February 20. In the article the general phenomena of explosion and the methods of measuring the relative value of explosives are discussed, much space being devoted to the phenomena of gaseous explosions. The general questions of the heat developed on explosion, the influence of mechanical forces, of chemical stability, and other minor points are touched upon. In conclusion, it is pointed out that the manufacture and employment of explosives are very complex questions, and demand long study; that in time of war it is not wise to introduce new explosives or great variation in methods of manufacture. Inventors and the public are apt to look more particularly for the production of explosives of enormous power without giving consideration to other all-important factors governing their production and application.

Engineering for March 5 contains an illustrated description of Lord Chetwynd's electrical steel-purification process, which has been in use for the past eighteen months at the Grimesthorpe Works, Sheffield, belonging to Messrs. Cammell, Laird and Co., Ltd. The steel is manufactured in the ordinary way in the Siemens-Martin furnace, and is then teemed into a special ladle. When teeming steel into a ladle in the ordinary way, a portion of the slag is drawn out with it, and becomes so intermingled with the steel in the ladle that it has no time to separate completely and to rise to the surface before the pouring into the ingot moulds takes place. Lord Chetwynd's process is applied to the steel in the ladle. Two graphite electrodes are made to rest in the layer of slag covering the molten steel in the ladle, and iron electrodes are fitted in the bottom of the ladle. As soon as the graphite electrodes are lowered into the layer of slag an electric current is made to flow through the steel, the effect of which is to raise the temperature of the metal, causing a rotating action throughout the molten mass, with the result that it is freed from the gases and slag particles which it contained in teeming from the furnace. The process lasts about thirty minutes, and the current expenditure is small. Test results show that the process has a marked refining action upon the metal in the ladle.

OUR ASTRONOMICAL COLUMN.

MELLISH'S COMET.—A note in the *Times* of March 10 states that the orbit of this comet obtained by Andersen and Fischer, of Copenhagen, places perihelion passage at about 1 p.m. on July 25 next, the distance being 110 million miles. The comet will remain visible to English observers up to the middle of May, by which time it is likely to be faintly discernible with the naked eye. It now rises about half an hour after midnight, the best time for observation being 5 a.m., when it is a little east of south. Its positions at 5 a.m. on the dates named are as follows:—

	R.A. h.	m.	s.	Decl. °	′
March 12	17	39	26	0	51 N.
16	17	44	16	0	29
20	17	49	5	0	4
24	17	53	50	0	22 S.

THE BRITISH ECLIPSE EXPEDITIONS OF 1914.—The January number (vol. lxxv., No. 3) of the *Monthly Notices of the Royal Astronomical Society* contains the preliminary reports of the various British expeditions which were dispatched last year to observe the total eclipse of the sun on August 21. These reports have now been issued also in a separate pamphlet, and distributed by the secretary of the Joint Permanent Eclipse Committee. Brief accounts of the work of each of these expeditions have already been given in this journal, so attention need only be directed to the handy collective publication mentioned above.

ASTRONOMY IN AMERICA.—With a strong editorial board the National Academy of Sciences of the United States of America has begun a publication of monthly proceedings. These proceedings will be official, and are intended to serve as a medium for prompt publication of brief original papers. It is intended that the papers will be shorter and less detailed than those published in journals devoted to special branches of science, and that they shall, if possible, include an introductory statement of the general aspects of the research, and of its relation to previous knowledge in the same field, so that its significance may be appreciated by those engaged in other branches of science. In the first number (January 15, vol. i., No. 1) astronomy is well represented by the following communications:—The radial velocities of nebulæ, by W. W. Campbell; Preliminary note on nebular proper motions, by H. D. Curtis; Discovery of the ninth satellite of Jupiter, by S. B. Nicholson; Spherical aberration in astronomical objectives due to changes of temperature, by F. Schlesinger; The relations between the proper motions and the radial velocities of the stars of the spectral types F, G, K, and M, by J. C. Kapteyn and W. S. Adams; and, finally, a critique of the hypothesis of anomalous dispersion in certain solar phenomena, by C. E. St. John.

GRUNDSPECTRA OF ALKALI AND ALKALINE EARTH METALS.—A research interesting to spectroscopists is that communicated to the *Astrophysical Journal* for January (vol. xli., No. 1, p. 16), by Mr. Edgar H. Nelthorpe. The work was carried out in the astrophysical laboratory of the Imperial College of Science and Technology, and deals with the observations of the *grundspectra* of alkali and alkaline earth metals. The term *grundspectra* refers to spectra obtained by Goldstein, who used a method by which line spectra of some elements were obtained which were totally different from their arc spectra and could not be arranged in series of the ordinary type. As Goldstein's method appeared in some cases completely to isolate enhanced lines (spark) from the arc lines occurring under the ordinary arc or spark conditions, the author of the present paper has repeated and extended this research, embodying some of the spectra of elements which are represented in stellar spectra. The elements here dealt with are sodium, potassium, rubidium, calcium, strontium, and barium. Mr. Nelthorpe describes the apparatus he employed, and gives the results of each element separately, accompanying them with a series of excellent photographic comparison spectra. The chief conclusion drawn is that the *grundspectra* obtained by Goldstein's method consist essentially of lines which are specially developed in the ordinary spark spectrum. In the case of potassium and rubidium the spectra consist entirely of enhanced lines, but with the calcium group the arc spectrum is not entirely absent.

ELECTRONS IN THE SUN'S ATMOSPHERE. In a paper communicated to the Tokio Mathematico-physical Society in October, 1914, Prof. H. Nagaoka directs attention to the important part which may be played by calcium in the production of electrons in the sun's atmosphere. In the flocculi so abundant in the photosphere it exists probably as calcium oxide, and the electronic emission of lime when incandescent is frequently utilised in laboratory work. At the pressure of one-tenth of an atmosphere which prevails in the calcium layer about a sun-spot, the electrical conductivity will not be too great to allow of considerable potential gradients which, according to their direction, will establish outward or inward electronic currents of considerable magnitudes. If, as seems most likely, the electric field is directed inwards, the electronic emission will be outwards and the regions of emission will be surrounded by electronic vortices with counter-clockwise rotation. Within the vortices magnetic fields will be produced, and the whole region will possess the properties found to exist in sun-spots. Comparisons of some of the consequences of this theory with observations are, it is hoped, to be carried out by the author and his pupils.

THE CHEMICAL INDUSTRIES OF GERMANY.[1]

THE interest and importance of the subject at the present time are sufficiently obvious. In outlining some of the origins of chemical industry in Germany, the lecturer pointed out how the royal house of Prussia had been frequently associated with chemical enterprise. The Markgrave John was actually surnamed "the Alchemist," the Great Elector was a patron of chemistry and provided a laboratory at Potsdam for the celebrated Kunkel, one of the first to discover phosphorus, and who also effected great advances in the manufacture of glass. Frederick the Great established the Royal Berlin porcelain factory, which still occupies some of the original premises. In the same reign also the chemist Marggraf made those classical investigations on the occurrence of sugar in the vegetable kingdom which later led to the foundation of the beet-sugar industry, which was initially subsidised by Frederick William III., the founder of the University of Berlin in 1809. (In 1914, the Berlin University had 12,585 students, and received an annual grant from the State of more than 200,000*l.*)

Great industries have developed out of these early steps. From the discovery of phosphorus came the match industry. German annual production of matches is 4,600,000*l.*; the British production in 1907 amounted to 775,000*l.*, whilst the British consumption in 1910 was estimated at 1,300,000*l.* Again, the porcelain and pottery manufacture had attained great dimensions in Germany, the exports in 1912 amounting to 3,556,000*l.*, whilst the glass industry was even on a larger scale, the recent annual exports being more than 7,000,000*l.* Great inconvenience in connection with all scientific work is at present being experienced through the absence of German glass. The important cyanide industry may be said to have taken its origin from the accidental discovery by Diesbach, of Berlin, of Prussian blue in the first decade of the eighteenth century. Germany's annual production of cyanides is now estimated at 10,000 tons (650,000*l*), or about one-half of the world's production.

The present position of Germany in the sugar industry of the world can be appreciated from the following figures:—

Total Sugar Crop, 1912–13.

	Tons
Cane-sugar	9 211,755
Beet-sugar, European (1/3 German) ...	8,310,000
,, United States	624,064
Total ...	18,145,819

The United Kingdom annually imports 1,700,000 tons of sugar (23,000,000*l.*).

	£		Acres
Germany annually produces	36,000,000	beet-sugar on	1,300,000
France ,, ,,	13,000,000	,,	570,000
All Continental countries	116,000,000	,,	6,000,000

The beet-sugar industry is of particular interest in connection with the present crisis because it is an example of an industry which received a most important impetus through the exclusion of British goods (colonial cane-sugar) from Continental ports during the Napoleonic wars.

This industry again exemplifies how agricultural production can be improved by systematic research such as has been bestowed on it by Germany, thus:—

In 1840	100 lb. of beet yielded	5·9	lb. sugar
1850	,, ,,	7·3	,,
1870	,, ,,	8·4	,,
1890	,, ,,	12·5	,,
1910	,, ,,	15·8	,,

Again in

1871	mean yield of beet per hectare of land was	246 quintals
1910	,, ,, ,,	300 ,,

And again in the economy of manufacture

In 1867	coal used on 100 lb. beet	35 lb.
1877	,, ,, ,, ...	24 ,,
1890	,, ,, ,, ...	10 ,,
1900	,, ,, ,, ...	7 ,,

As indicating the great and progressive attention devoted to agriculture, Germany's artificial manure bills for 1888 and 1912 were highly instructive:—

	1888. Tons	1912. Tons
Chile saltpetre ...	225,000	650,000
Sulphate of ammonia	50,000	500,000
Superphosphate ...	250,000	1,800,000
Basic slag	250,000	2,200,000
Crude potash salts ...	160,000	3,000,000
Lime...	— } 500,000	800,000
Other manures ...		500,000
Total value ..	£30,000,000	

The following comparison is also of interest:—

Use of Artificial Phosphatic Manures (per annum).

England	48 lb. per 1 acre cultivated
France	105 ,, ,,
Germany	105 ,, ,,

The former supremacy of Great Britain in the manufacture of the common chemicals—sulphuric acid and soda—was referred to, and compared with the production of these materials in 1910.

Production in Tons, 1910.

	Germany	England	France	U. States	World
Sulphuric acid	1,250,000	1,000,000	500,000	1,200,000	5,000,000
Soda	400,000	700,000	200,000	250,000	2,000,000

The substitution of the ammonia-soda for the earlier Le Blanc soda process, and of the contact for the time-honoured leaden chamber process of sulphuric acid manufacture, had no doubt greatly assisted both Germany and America in becoming independent of the British manufacture of these chemicals.

During the past twenty-five years the manufacture of chlorine and caustic soda by the electrolysis of common salt (sodium chloride) has been realised and rapidly extended. This process is carried out on a very large scale in Germany, where extensive use is made of liquefied chlorine. The production of electrolytic chlorine is attended with the simultaneous evolution of large quantities of hydrogen gas for which uses have been found; thus, for filling the dirigible balloons upon which such hopes of conquest have been based by Germany, whilst in the oxyhydrogen flame it has been employed for welding, for the cutting even of thick iron structures, and for the manufacture of artificial gems. The artificial production of gems—corundum, ruby, sapphire, etc.—was discovered in France by Michaud, Verneuil, and Paquier, and has been greatly taken up by the Elektrochemische Werke at Bitterfeld, in Germany. More than a ton of these gems, which are identical in chemical composition with the natural gems, are said to be annually produced. Other more important uses for hydrogen have been found for the hardening of fats, and still more recently for the synthetic production of ammonia to be presently referred to, and which is an industrial achievement of the first magnitude. Cheaper sources of hydrogen than the electrolytic method have been

[1] Abstract of a lecture delivered before the Society of Chemical Industry (Birmingham and Midland Section), in the University of Birmingham, on March 4, by Prof. Percy Frankland, F.R.S.

introduced, and notably that depending on the production of water-gas (consisting of equal volumes of hydrogen and carbon monoxide) from steam and coke at a red-heat, the carbon monoxide being subsequently separated from the hydrogen by liquefying it by means of the low temperature apparatus of Carl von Linde, of Munich.

The discovery of incandescent gas lighting by the Austrian, Count Auer v. Welsbach, and of the metallic filament incandescent electric lamp by the same inventor in 1903, as well as the improvements in the latter effected by Siemens and Halske in 1905 and 1906, have led to the production of these commodities on a very large and increasing scale in Germany, thus:—

	1911	1912
Incandescent gas mantles	126,000,000	135,000,000
Metallic filament electric lamps ...	47,000,000	76,000,000
Carbon filament lamps (production diminishing)	25,000,000	21,000,000

The following comparison of the estimated consumption of incandescent gas mantles in different countries for the year 1912 is interesting (Vivian B. Lewes):—

Germany ...	100,000,000	Belgium... ..	3,500,000
America ...	60,000,000	Italy	3,000,000
England ...	38,000,000	Russia	1,500,000
France ..	16,000,000		

Ammonia, Nitrates, and Fixation of Free Nitrogen.

During the past century the world's supply of ammonia has been almost exclusively obtained as a bye-product in the manufacture of gas, and latterly also from coke-ovens. So backward was Germany in the production of ammonia that as late as 1874 the ammoniacal liquor of their gasworks was allowed to run to waste. All the more remarkable is the state of affairs revealed by the following figures:—

	Tons
In 1890 the world's production of sulphate of ammonia	210,000
1900 ,, ,, ,, ,,	500,000
1912 ,, ,, ,, ,,	1,330,000
1910 Germany's ,, ,, ,,	300,000
1912 ,, ,, ,, ,,	400,000

The principal use of sulphate of ammonia is as a nitrogenous manure, as which it competes with Chile saltpetre (sodium nitrate).

Sulphate of ammonia contains 20·5 per cent. nitrogen
Chile saltpetre (sodium nitrate) 15 ,, ,,

It has already been pointed out that Germany imports 650,000 tons of Chile saltpetre for manure, hence by increasing their output of sulphate of ammonia they have been rendering themselves less dependent on foreign products (nitrate from Chile and sulphate of ammonia from England).

As is well known, one of the most important problems at the present time is to provide the world with nitrate when the deposits in Chile shall have been exhausted. The problem is bound up with the still wider one of the fixation of atmospheric nitrogen. This again, as is well known, is now accomplished on a large scale by the production of nitric acid from atmospheric nitrogen and oxygen by means of the electric furnace of Birkeland and Eyde, or by the production of calcium cyanamide by passing atmospheric nitrogen over heated calcium carbide. Both these processes involve the use of the electric furnace, in the former for effecting the union of the nitrogen and oxygen, and in the latter for the preliminary production of the calcium carbide. Abundant water-power being necessary for the economic operation of the above processes, Norway has become their chief centre, whilst Germany has sought other means of nitrogen-fixation which could be carried on within her own territories. The synthesis of ammonia from hydrogen and atmospheric nitrogen under a pressure of 200 atmospheres and at 500° C. in the presence of a catalyst, has been successfully worked out by Haber in conjunction with the Badische Anilin und Sodafabrik, and a plant capable of yielding 130,000 tons of sulphate of ammonia per annum was to have been ready in 1915. The second step in the German programme was to convert the ammonia into nitric acid by burning it in air in the presence of a catalyst. In this way it is hoped to make Germany independent of foreign countries for the nitrate required in the manufacture of explosives. It is asserted that this independence Germany has actually secured at the present moment.

Potash Salts.

The unique deposits of potash salts discovered at Stassfurth in 1857 have been exploited on an increasing scale and have furnished practically the whole world with potash; the output of crude salts was in

	Tons	£
1881	2,000	
1912	11,000,000	(8,800,000)

In 1911 America alone took potash salts to the value of 3,000,000*l.*

Explosives.

Of the modern high explosives, gun-cotton was discovered by Schoenbein and by Boettger in 1846. The manufacture of nitroglycerine (discovered by Sobrero in Paris in 1847) was first realised by the Swede, Alfred Nobel, in 1862, and it was Nobel who first adapted these powerful explosives for ballistic purposes. Trinitrotoluene, of which so much has been heard recently, was first proposed for filling shells by Haessermann in 1891. It is said to be surpassed, both as regards safety and disruptive effect, by tetranitro-aniline discovered in England by Dr. Fluerscheim. The great magnitude of the German explosives industry is seen from the following figures:—

	Tons
Total German production of explosives ...	40,000
or about 1/10th of the estimated world production.	
	£
Germany exported in 1908 to the value of	1,000,000
,, ,, 1912 ,,	3,000,000

Artificial Silk.

This remarkable industry, originated by Count Chardonnet in France in 1891, has also been largely developed on German soil. The German production amounts to about 2000 tons annually (1,200,000*l.*) out of a total world production of about 7000 tons. French, German, and British patents have largely contributed to the success of this industry.

Industries Dependent on Synthetic Organic Chemistry.

It is in respect of these industries that the world is learning that Germany holds the undisputed supremacy. It is in Germany alone that manufacturers have been found prepared to embark their capital and undertake industrial enterprises of the first magnitude on the advice of the organic chemist. The success which has been achieved by the German manufacturers of artificial dyestuffs, drugs, and perfumes, and the hegemony which they have secured in this branch of industry, has been the frequent subject of warning by professors of chemistry in this country for upwards of a generation. The seriousness of the situation which has arisen through the neglect of those warnings is seen from the following figures:—

		£
Annual value of dyestuffs used in England	...	2,000,000
,, trade in which these dyes are employed	...	200,000,000
Workmen dependent on this trade 1,500,000		
Total value of dyestuffs imported (1913)	...	1,892,055
,, ,, ,, from Germany		1,730,821

Thus less than 1/10th of the annual value of the dyestuffs consumed in England is produced in this country. Thus, by controlling the dyestuff industry, Germany indirectly holds in her grip the much larger textile industry.

The manner in which the coal-tar colour industry has extinguished the cultivation of madder more especially in France, since 1870, and has caused the cultivation of indigo in British India to dwindle almost to nothing since 1897, are now well-known facts in commercial history. They will be fully appreciated by a study of the following figures:—

At the time of the discovery of artificial alizarin (the dyestuff contained in madder) in 1869, the total production of natural alizarin amounted to between 500 and 750 tons (2,250,000*l.*), and in 1870 France had 50,000 acres under madder cultivation.

The production of artificial alizarin was

	Tons
In 1873	100
1877	750
1884	1350
1900	2000

(4/5ths of this produced in Germany).

Again, with regard to indigo, in 1896 the world's production of plantation-indigo was valued at about 4,000,000*l.*, of which four-fifths were obtained from British India.

Export of Indigo from British East Indies.

	£
1896	3,569,670
1899	1,980,319
1902	1,234,837
1905	556,405
1908	424,849
1911	225,000
1913–14	60,000–70,000

Since the introduction of artificial indigo the price of indigo has been reduced by more than one-half, but since the outbreak of the war the price of indigo has advanced by 350 per cent.

Much inconvenience has been experienced also in the shortage of artificial drugs and consequent high prices, more especially at the beginning of the war, as even the simplest of these products were almost exclusively made in Germany. The manufacture of some of these is, however, now being successfully carried on in England.

Again, the shortage of organic chemicals required for research purposes, which practically all come from Germany, is occasioning most serious difficulties in our university laboratories.

For the manufacture of dyestuffs and similar synthetic products Germany was formerly largely dependent on England for the raw material—coal tar. But in this case, again, the ambition of Germany to become in all respects independent and self-contained has led her in recent years to make the most strenuous efforts to recover the maximum amount of coal-tar both from the manufacture of gas and from coke-ovens, which endeavour has been assisted by the enormous growth in her iron and steel industries. Thus in 1897 Germany obtained only 52,000 tons of coal-tar from coke-ovens, whilst in 1908 she obtained no fewer than 632,400 tons from that source, besides 300,000 tons from the manufacture of gas. Thus at the present time the German output of coal-tar about equals, if it does not exceed, that of England.

The German production of artificial perfumes is said to amount to a value of about 2,500,000*l.* annually. In this department of applied chemistry, again, one of the first steps was made by the late Sir William Perkin, by the synthesis in 1868 of coumarin, the much-valued odoriferous principle of woodruff (*Asperula odorata*).

The great magnitude of the German coal-tar colour industry may be gathered from the fact that the two groups into which the principal firms are associated have at the present time a total share-capital of about 12,000,000*l.*, on which a dividend of about 28 per cent. is paid. In 1912 Germany produced dyestuffs to the value of 12,500,000*l.*, of which to the value of 10,000,000*l.* were exported.

The proposal of the Government to assist the British coal-tar colour industry is being watched with the greatest interest both by manufacturers and chemists. The problem of relieving the immediate shortage during the war must be carefully distinguished from the later problem of securing the independence of the home-industry after the war by greatly increasing the British output. The realisation of the latter object will be attended with the greatest possible difficulty. The industry will require "nursing" for a great many years. The undertaking must be possessed of such elasticity that it can ramify into other branches of chemical or other industry whenever advantageous opportunities arise for such departures. Chemists must form an integral part of the directorate, which must be prepared to spend large sums of money on judiciously conceived and well-organised research, for which the sum of 100,000*l.* in ten years, hitherto mentioned by the Government, is ridiculously inadequate. The undertaking must, moreover, be freed from all hampering legislation with regard to restrictions in the use of alcohol, ether, chloroform, and other chemicals. In short, the rehabilitation of the industry in this country will not be effected by following the precept "business as usual," but by pursuing a policy which is quite the reverse of what is implied by that undignified phrase.

BRITISH ASSOCIATION DISCUSSION OF THE NATURE AND ORIGIN OF SPECIES.

An outstanding feature of the Melbourne meeting of the British Association was the joint debate by Sections K and D (Botany and Zoology) on the nature and origin of species. Prof. F. O. Bower, President of Section K, took the chair.

Dr. A. B. Rendle pointed out the need of a working unit for the classification of the world's flora. A working systematist or monographer recognised certain characters common to a number of individuals as limiting varieties, species, and genera from one another. Such expert work was difficult, and inclined to be at times individualistic, but was necessary if systematic botany was to exist. Dr. Rendle showed himself a thorough supporter of the well-known Darwinian explanation of the origin of species by natural selection. The living organism is eminently adapted to its environment or is epharmonic. Slight gradual changes in the organism due to internal causes, influenced or not by slight changes in environment, accumulate and become inherited. If these changes are pronounced, *e.g.*, sports or monstrosities, they are likely to be detrimental to the individuals possessing them. To grow plants under alien conditions generally requires care and freedom from competition. He thought experiments conducted under control in the laboratory or greenhouse partook too much of the nature of hospital treatment, and that conclusions based on such work were scientifically unsound. The open field of nature was the more trustworthy as the interplay of forces there had nothing personal in it. He could not accept the theory offered by De Vries and others of the origin of species by mutation, namely, by the inheritance of striking changes suddenly appearing, that is to say, discontinuous variations, as distinguished from the non-heritable fluctuations of slight degree. The inheritance of the discontinuous variations gives rise by a process of segregation to the elementary species of De Vries. The Darwinian species arises, on the contrary, by selection by an aggregation of slight gradual epharmonic changes.

Dr. Rendle took as an example of the difference of interpretation under the two opposing views the work of Jordan on the Drabas and of Wettstein on alpine meadows. He showed no sympathy for Lotsy's view of the origin of species by crossing. The resulting forms would be in 90 per cent. of the cases of the nature of monstrosities, and incapable of perpetuating themselves. They would be too, as regards environment, unharmonic. In conclusion, he considered the latest suggestion made by Prof. Bateson, that new forms arise by the omission of a character, to be full of difficulties. On this view the highest phase of evolution would correspond with the disappearance of all characters, while the primitive organisms must have been inconceivably complex.

Prof. A. Dendy, President of Section D, considered that species arise by a process of fundamental evolution, in which environment plays a leading part, and that the adaptations are inherited. The epigenetic characters are, however, modified by sexual reproduction, giving permutations and combinations, following Mendelian laws, which are superposed on the modifications due to Darwinian evolution.

Prof. W. Bateson, President of the Association, did not himself attach so much importance as some of the speakers to the standardisation of the term species. He thought it hopeless to expect definite conclusions as to the nature and origin of species along the lines advocated by Dr. Rendle.

The reason that unquestionable judgments could not be reached was obviously that the physiological nature of specific difference was still unknown. In the absence of this knowledge the delimitation of species must be arbitrary. Many, following Darwin, hold that the distinction between species and variety was a matter of degree. That might be so, but he (the speaker) inclined to doubt it. No one, however, as yet had evidence on which a confident opinion as to that fundamental point could be based. Such evidence, if indeed attainable, could be reached only by physiological experiment—experiments in breeding providing as yet the most hopeful line. No amount of inspection of specimens, living or dead, could decide specific limits. Names must, of course, be given, and freely. Systematists perhaps do well to indicate which names they regard as prerogatively specific; but it should clearly be understood that these decisions were pragmatical and matters of convenience, and they should not be offered as indications of physiological significance.

Prof. E. B. Poulton thought there was too much assumption in the distinction drawn by De Vries between his non-heritable fluctuations and his discontinuous heritable variations as regards their heritability. He (Prof. Poulton) agreed with Prof. Dendy in laying stress on the importance of sexuality in producing new patterns by the endless combinations of units. He thought environment alone was not enough to account for the production and continuance of a variety. There must be selection too.

Prof. Benjamin Moore caused his audience much amusement by stating that although he had been compared in the President's address to Harry Lauder's schoolboy who took from his pocket a washer and said "that's to mak' a motor-car," yet if he were starting to collect materials for building a motor-car he would rather begin with a washer than a pot of enamel paint. Workers at different levels on the subject of evolution were apt to despise one another's work or misunderstand it. The problem of the origin of species, just like the problem of the origin of atoms, was fundamentally a chemical problem, and in its study the effects of energy transformations acting from without upon the living cell acting as a catalyst must be taken into account. The outside sources of energy formed the environment, and this environment acted as a directive, screening, and selective factor causing small variations.

Prof. E. A. Minchin said that speaking quite generally and ignoring for the moment intermediate and transitional forms, he believed that two principal grades of evolution would be recognised in the Protista, exemplified by the Bacteria and Protozoa respectively. In the bacteria the full structure of the cell has not been attained, and there are no sexual processes. In the Protozoa, on the other hand, the individual is a complete and typical cell, and sexual phenomena occur. In the bacteria the so-called species are groups of individuals in which the variability is indefinite and uncontrolled. In the Protozoa the variations are reduced to a common level by sexual blending, and fixed species occur. He believed that in the unicellular Protista one of the effects of the sexual powers is to produce true species by controlling and levelling down variability.

Mr. J. T. Cunningham expressed the view that recent discoveries concerning internal secretions or hormones gave evidence of a physiological process which would make the transmission of functionally produced modifications possible.

Dr. F. A. Dixey thought that the principle of segregation of the gametes, especially as reinforced by the President's suggestion of "fractionation," has thrown light on the persistence of some forms and the appearance of others. It would seem that adaptation can only be satisfactorily accounted for on the basis of selection applied to small inheritable variations.

Mr. R. P. Gregory and Dr. G. C. Druce also spoke. T. J.

FORTHCOMING BOOKS OF SCIENCE.

IN addition to the forthcoming books of science referred to in recent issues of NATURE we notice the following publishers' announcements:—*D. Appleton and Co.* The Fundamentals of Plant Breeding, J. M. Coulter; Psychology, General and Applied, H. Munsterberg; Sanitation in Panama, W. C. Gorgas. *The Cambridge University Press.*—The Teaching of Mathematics, Prof. T. P. Nunn (Cambridge Handbooks for Teachers). *J. M. Dent and Sons, Ltd.*—An Introduction to the Study of African Languages, Prof. Meinhof, translated by A. Werner; Elementary Experimental Statics, I. B. Hart. *G. G. Harrap and Co.*—Scientific Management in Education, Dr. J. M. Rice; An Industrial Geography of Britain, W. J. Claxton *T. C and E. C. Jack.*—German Culture, edited by Prof. W. P. Paterson, the aim being to give an estimate of what Germany has contributed to higher life and thought in the various departments of knowledge. The following subjects will be dealt with, among others:—German Science, Prof. J. Arthur Thomson; German Philosophy, Prof. A. D. Lindsay; Political Philosophy and Politics, Prof. D. H. Macgregor; German History and Character, Prof. R. Lodge; Modern Inventions, V. E. Johnson; Electricity, W. H. McCormick; Engineering, G. Knox. *Longmans and Co.*—The Development and Present Position of Biological Chemistry, Prof. F. G. Hopkins; The Polysaccharides, A. R. Ling; Colloids, W. B. Hardy; Respiratory Exchange in Animals, Dr. A. Krogh; Protamines and Histones, Dr. A. Kossel; Organic Compounds of Arsenic and Antimony, Dr. G. T. Morgan; Lecithin and Allied Substances, Dr. H. Maclean; The Ornamental Plant Pigments, A. G. Perkin; Chlorophyll and Hæmoglobin, H. J. Page (Monographs on Biochemistry); Electric Waves, Prof. G. W. Pierce; The Emission of Electricity from Hot Bodies, Prof. O. W. Richardson; Colloidal Solutions, Prof. E. F. Burton; Atmospheric Ionization, Prof. J. C. McLennan (Monographs on Physics); Electrolytic Dissociation Theory, Dr. J. C. Philip; The Physical Chemistry of Flames, J. E. Coates; Clays, Dr. J. W. Mellor; Catalysis of Gas Reactions, D. L. Chapman; The Electro-Chemistry of Non-Aqueous Solutions, J. W. McBain; Catalysis in Liquid Systems, Dr. G. Senter; Hydrates in Solution, Prof. E. A. Washburn; The Rare Earth Metals, Dr. J. F. Spencer; The Molecular Volumes of Liquid Chemical Compounds, G. Le Bas; Adsorption, V. Lefebure and A. M. Williams (Monographs on Inorganic and Physical Chemistry). *J. Nisbet and Co., Ltd.*—The Operative Treatment of Chronic Intestinal Stasis, Sir W. A. Lane. *Sir Isaac Pitman and Sons, Ltd.*—Experimental Physics, A. Cowling. *T. Fisher Unwin.*—Rubber Recueil: Papers on Rubber, its Botany, Culture, Preparation, and Commerce.

THE SECOND INDIAN SCIENCE CONGRESS.

THE second Indian Science Congress was held in Madras from January 14–16. It may be remembered that the suggestion to hold a Science Congress in India on the lines of the British Association was first made some three years ago by Prof. MacMahon, of Lucknow, and Prof. Simonsen, of Madras. The first meeting was held a year ago in Calcutta.

The Hon. Surgeon-General W. B. Bannermann, I.M.S., C.S.I., was president this year, and delivered on address entitled "The Importance of a Knowledge of Biology to Medical, Sanitary, and Scientific Men Working in the Tropics." After dealing with the scourges of India and recent research as to the nature of plague, malaria, and so on, the president remarked:—"It has been said that Indians have not yet distinguished themselves as they might in the domain of medical research. That is no doubt true, but the reason is not far to seek. The leisured and wealthy classes in India do not send their sons to our universities in any numbers, and when they do, certainly not with the idea that they should spend the rest of their lives in pure research work. Let us hope they will do so some day. It is, therefore, among the sons of the middle class and often poor community that we must look for the men with capacity and inclination for such work.

"But these are the very men who, not being in independent circumstances, must earn their living at the earliest possible time. They cannot, therefore, be expected to engage in scientific research which does not bring in money for daily bread or lead up to any permanent appointment. I would, therefore, appeal to our wealthy Indians to endow medical research, so that their poor but capable fellow-countrymen may have something to look forward to as reward for scientific toil. There are plenty of subjects for research which ought to be endowed, chairs in our medical schools and universities that ought to be established. All our Indian universities are at present mere skeletons; will no one here take up the rôle of beggar and try to extract a few lakhs of rupees from the hoards of his wealthy and aristocratic friends? We know that there is plenty of money to be had when the heart of the nation is touched, as witness the magnificent response to the appeals made for war funds by H.E. the Viceroy and our own Governor of Madras. It must be your part, gentlemen of light and leading, to inspire similar enthusiasm in the good cause of university endowment. India wants to have, not only more chairs and lectureships endowed, but also research scholarships or fellowships established; fellowships available for the student and the research worker, so that he may live in reasonable comfort, and be able to devote his whole energy to the work without anxiety for those depending on him.

"I should like here to point out that we in Madras have made a beginning in this direction owing to the enlightened liberality of the Rajah of Pithapuram, who has presented 50,000 rupees for the expenses of an inquiry into diabetes, that fell disease which carries off so many of the best brain workers in this part of India. This is an example which I trust will often be followed in the future; it can lead to nothing but good for India and her peoples.

"You will remember what our late beloved King-Emperor said with reference to tuberculosis:—'If preventible, why not prevented?' We may say the same of all these diseases—'They are preventible; why are they not prevented?' For their prevention we require research and research workers. Research workers are, after all, human beings and must be able to support themselves and their families by their labours. Who will come forward and help us? India needs this help, and we cannot look to Government for more than a small part of the money required. Government has done magnificent work of late years in establishing laboratories, and subsidising research all over the land, but much more is required. We want scholarships and fellowships with pensions for our best research workers. Endowments for this purpose will do more to keep alive the memory of the donors than the erection of chattrams or other traditional forms of charity. It will not merely do this but will confer an inestimable benefit on the inarticulate millions of India, who do not even know that they can be delivered from the various diseases that afflict them, and are scarcely conscious of their existence.

"But we not only require research workers, we want an organisation that will help to educate the people in the ordinary rules of health. There should be in each presidency an official whose business it is to look after the hygienic education of the common people. He should be in charge of a Bureau of Public Health, and his work should consist in preparing pamphlets and popular lectures with lantern-slide illustrations, which could be lent to lecturers who would undertake to itinerate in the villages and talk to the common people. He should organise classes for the teachers in our teachers' colleges, and he should gather together and popularise information from every quarter. Such an official—who would have to be very specially selected—would do an immense amount of good in educating the people, and without education we can hope for very little advance along the road to health.

"Until the usefulness of such a bureau is fully established, we can perhaps scarcely expect much help from Government, for it has plenty to do with the public revenues, but I am quite sure they would view any endeavour to educate the masses with a sympathetic eye."

After the presidential address it was decided to hold the 1916 meeting in Allahabad, and Dr. W. N. F. Woodland was appointed the local hon. secretary.

In the Agriculture and Applied Science Section Dr. H. H. Mann, of Poona, presided, and his address dealt with "The Lines of Development of Indian Agriculture."

Agriculture in India, he said, is of two kinds. On one hand you have an extensive agriculture, conducted without much capital, with primitive implements and methods, and yielding poor results when compared with any Western standard. On the other, you have a number of comparatively small, but highly organised industries, conducted largely by planters, growing special valuable crops, with adequate capital, and yielding exceedingly high returns.

It is not generally realised how unsatisfactory the results of the average Indian agriculture really are. We have no census of production in India as yet, and really satisfactory figures are not possible. But in a few cases it is possible to give figures which make us realise the position. In wheat production, for instance, the yield per acre is certainly not more than ten bushels per acre, and is probably nearer eight, or one-third of what might be considered as a good crop; more especially in this case where so much of the land devoted to it is irrigated and hence not dependent on a very variable rainfall. In the case of cotton, the figure is equally striking, and in this case the area and production are very fairly well known. From twenty-two million acres, the produce runs to above four million bales, or about 75 lb. of lint per acre, while in America, with an equally uncertain rainfall, the production reaches 200 lb. per acre. Again, if we take an intensive crop grown very largely under irrigation, like sugar-cane, the yield works out at under one ton of raw sugar per acre, as against a world's average of about two tons at least. In this case the average in India is very much lowered by the miserable outturn from Northern India, and the crop in Bombay and Madras is fairly up to the world's average. These figures are so striking that a newcomer to the subject is apt to think that improvement is easy, and that the raising of the standard of this cultivation towards that reached elsewhere is not very difficult.

This, however, is not the case. In no country perhaps is progress more difficult. One is hindered at every point by unexpected difficulties. The lack of anything more than a minimum of capital has been often considered as the most outstanding of these hindrances, and it is very important, though not the only one. The very great conservatism of the Indian cultivators has often, also, been mentioned. In this matter, it may be stated very emphatically that Indian cultivators are not more conservative than their situation demands. When a man is working on a minimum of capital, when any excess capital costs probably from 12 per cent. upwards for interest, when the money is turned over only once or at most twice in a year, it is the only policy to be extremely conservative.

Three methods of investigation seem important with a view of improving matters. One of these is the study of soil physics. It seems very important here, especially as several of our types of soil are peculiar, that the methods of increasing their absorbing and retaining capacity for water under our conditions required very careful investigation. A second investigation, that of implements, is one which is very much needed. A third method, to increase the utility of the water which actually falls in our drier tracts, is the development of drought-resisting varieties of plants.

Mr. F. M. Howlett, in his paper, termed "Chemical Entomology," stated that insects are usually easy to influence by one sense, and one alone. In the case of one small fly a small trace of *iso*valeric aldehyde will bring many thousands of them to a place in a short time, though none were present before. Among the fruit-flies, the maggots of which are found in many fruits, the scent is so well developed and so distinct that each species seems to be attracted by a different smell.

Dr. Coleman, of Bangalore, read two papers on the black rot of coffee, and the "koleroga" disease of the areca palm. He thinks that it is likely that by treatment with Bordeaux mixture black rot of coffee can be checked. The second paper, on the areca palm disease, told the story of one of the very few successful campaigns in India against a destructive disease of the betel nut, which threatened the industry in some districts of Mysore.

In the Physics Section, the contributions of the chairman, Mr. C. V. Raman, on the velocity of restitutions after impact between various elastic materials and his speculations as to the type of air disturbance involved in the click of two billiard balls, aroused a good deal of interest. Among other papers were:—Dr. D. N. Mallik, on a type of electric discharge in the neighbourhood of a permanent magnetic pole; Dr. Royds, on spectrum series; Mr. C. Michie Smith, on the climate of Kodaikanal; Mr. S. Appaswami, the Madras Physics Department, the motion of violin strings; Mr. J. Evershed, of the Kodaikanal Observatory, on sun-spots and prominences. In all twelve papers were read and discussed.

In the Chemical Section Dr. P. C. Ray, of Calcutta, presided, and fourteen papers were communicated. The chairman opened the proceedings by giving a brief account of his recent work on the use of nitrites and chloroacetic acid in causing tautomerisation in certain thio-derivatives, and in a further paper discussed the action of alkyl iodides on dimercuriammonium nitrite. Prof. J. J. Sudborough dealt with alcoholysis, and also gave an account of work which he was carrying on with his students on the replacement of sulphonic acid groups in aromatic compounds during halogenation. Prof. Neogi and Mr. Chowhari described their experiments on the conversion of aliphatic nitrites into nitro-compounds. Prof. Joseph, of Colombo, gave an account of his and Mr. W. N. Rae's work on chromium phosphate. Profs. Gibson and Simonsen communicated two papers on stereochemical problems, in one of which the resolution of β-naphthotetrahydroquinaldine was described.

The Section of Zoology was presided over by Dr. N. Annandale, of the Indian Museum. The two most important papers before the meeting were those on the autotomy and regeneration of the tail in the house-gecko and on the zoanthids of Madras. They were by Prof. W. N. F. Woodland, of Allahabad, and Prof. K. Ramunni Menon, of Madras, respectively.

Dr. C. A. Barber, of Coimbatore, the chairman of the Botany Section, in his opening address, took sugar and the sugar-cane as his subject. The history of the industry in Java was studied in detail as showing a fine example of the application of scientific work to sugar-cane problems. The question whether India (which now imports nearly a million tons each year) could hope to become an exporting country was answered in the negative. It was shown that India was a quarter of a century behind Java, and was, in fact, only just commencing scientific sugar-cane work. Recent work in India was discussed, especially the efforts to improve the local varieties and the raising of seedling sugar-canes in the newly founded cane-breeding station at Coimbatore. Mr. F. R. Parnell, of Coimbatore, read a very interesting paper on some Mendelian characters of the paddy plant. Dr. W. Burns and Mr. S. H. Prayag described experiments on inarching inflorescence of the mango when a union was made and the fruit of one tree was thus borne on a tree of another variety. Prof. P. F. Fyson discussed the phanerogamic flora of the patana regions of the Nilgiris and Pulney Hills, pointing out the affinities with Ceylon, the Vehasia, and Himalayan regions.

Other papers were by Mr. M. O. Parthasarathy Iyengar, on the defoliation of some Madras trees; by Dr. C. A. Barber and Mr. D. Vekataraman, on the depressed habit in the sugar-cane; and Mr. C. Tadulingam on the Madras flora.

The meeting of the Geological Section was presided over by Dr. W. F. Smeeth, State Geologist of Mysore, who read a paper on the geological history of southern India, and gave an account of the character and distribution of the various components of the great archæan complex as developed in Mysore. Babu H. C. Das Gupta described an occurrence of crystalline limestone from the Daltonganj coalfield. Mr. E. Masillamany dealt with certain basic dykes in Travancore, including gabbro, dolerites, and norites, the petrology and field relationships of which were discussed.

The Section of Ethnography met under the chairmanship of Mr. H. V. Nanjundayya, whose address was on some aspects of ethnographic work. He said that the lower castes are aspiring to a higher status; Gotras are claimed, and customs which enable the observer to recognise the lower caste are suppressed. According to legend the Castes claim descent from God, but actually Castes are considered to be tribal distinctions. By the adoption of Samskaras of higher castes and practising them for several generations higher status is claimed, and renders investigation a matter of considerable difficulty. Dr. Annandale, in a paper entitled "Anthropometric Notes of Calcutta Eurasians," dwelt on the importance of regarding physical anthropology from a zoological point of view. He expressed the opinion that the primary classification of the races of man should be conducted on exactly the same lines that would be adopted in investigating those of any other species. Unfortunately the characteristic features of the different human races were still very imperfectly known, and existing systems of anthropometry were unsatisfactory in many respects. He had no new system to expound, but laid stress on the value of a large series of photographs taken on a definite system and illustrating as far as possible the actual external structure. He put forward a proposal for a photographic survey of the people of Calcutta, and especially of those of mixed race. Dr. Ketkar, of Bombay, read a paper on Indian sociology as a theoretical and applied science. Dr. S. C. Roy read a paper on totem worship amongst the Oraons. The author showed that Kachchapa (tortoise) must have given rise to the Gotra, now known as Kasyapa. The existence of a wooden figure of the tortoise and pig seemed to bear out the theory suggested by him. Other papers in this section were contributed by Mr. Gopinatha Rau, on viragals and mastigals—the memorial stones set up in honour of heroes who fell in battle and women who died for their husbands; Mr. L. K. Ananta Krisna Iyer read papers on prehistoric monuments in Cochin, and on the Vettuvans of North Malabar.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The subject proposed for the Adams Prize Essay for the period 1915–16 is "The Course of Evolution of the Configurations possible for a Rotating and Gravitating Fluid Mass, including the Discussion of the Stabilities of the Various Forms." The investigation of the forms that can be assumed by a mass of gravitating fluid endowed with motion of rotation was initiated by Newton with reference to the figure of the earth, developed by Maclaurin, Clairaut, and Laplace, and extended by Jacobi. It was consolidated in Lord Kelvin's hands, as an example of the doctrine of the dissipation of energy, into a single problem illustrating the course of evolution of stellar and planetary systems. The sequence of the forms that can be assumed by a rotating fluid mass, first announced partially by Lord Kelvin, has been extended and systematised by the work of Poincaré, and expanded in new directions by Sir G. H. Darwin and other investigators. Further elucidation of this succession of forms, especially in the direction in which a tendency appears for the mass to divide into separate parts, is desirable, in view of its possible bearing on the modes of evolution of double and variable stars and the interpretation of other remarkable celestial objects. The case in which the mass is in whole or in part in the gaseous state may also present opportunities for investigations possessing astronomical interest. Some contribution to the further theoretical development of this subject is asked for. The prize is open to the competition of all persons who have at any time been admitted to a degree in the University. The value of the prize is about *220l.* The essays must be sent to the Vice-Chancellor on or before the last day of December, 1916.

OXFORD.—On March 9 Congregation approved the appointment of Dr. H. M. Vernon, fellow of Magdalen College, as University lecturer in chemical physiology for four years, in succession to Dr. Ramsden, fellow of Pembroke College, who has been elected to the post of Johnson professor of biochemistry at Liverpool University. Congregation has also approved the re-appointment of Dr. J. W. Jenkinson, Exeter College, as University lecturer in comparative and experimental embryology for five years.

The Hebdomadal Council has lately put out an important statement dealing with the financial position of the University as affected by the war. It is estimated that, after allowance has been made for a considerable saving in the conduct of examinations, the statutable and necessary expenditure for the current year will exceed the ordinary receipts by at least *15,000l.* This deficit may be reduced by various expedients, such as savings in respect of grants, and the suspension of repayment of loans (should the necessary powers be granted by the Bill now before Parliament), to a sum of about *6000l.* The remainder may ultimately have to be made good by borrowing; but before the necessity for this step arises, the situation will, it is hoped, be to some extent relieved by the voluntary contributions of many of the officers and other members of the University.

IT is stated in *Science* that Dr. William J. Mayo and Dr. Charles H. Mayo, of Rochester, Minn., the distinguished surgeons, have decided to establish a *200,000l.* foundation for medical research and to place the foundation, under certain restrictions, in the hands of the University of Minnesota.

We have received from the University Press of Liverpool a copy of a report of the Senate of the University upon research and other original work by members of the University published or completed during the session 1913-14. The titles of papers and other publications are arranged under faculties and numbered consecutively, those published during the session being placed first. The abbreviations adopted in the titles of scientific periodicals are those used in the "International Catalogue of Scientific Literature."

At a meeting held in New York, on January 27, in connection with the inauguration of the Engineering Foundation, it was announced, says *Science*, that the initial gift had been made by Mr. Ambrose Swasey, past-president of the American Society of Mechanical Engineers, who has given 40,000*l.* for "the advancement of the engineering arts and sciences in all their branches to the greatest good of the engineering profession and for the benefit of mankind." The administration of the fund will be entrusted to the Engineering Foundation Board, elected by the trustees of the United Engineering Society. From the same issue of our contemporary we learn that the sum of 8000*l.* has been given by Mr. Andrew Carnegie to Allegheny College for a chemical laboratory to replace that recently destroyed by fire; and that Mr. Patten, who has already given 100,000*l.* to the medical school of Northwestern University, has now added 5400*l.* for scholarships.

The Department of Agriculture and Technical Instruction for Ireland has issued particulars of the summer courses of instruction for teachers to be held this year in Ireland. The courses, with the exception of that in rural science for national school teachers to be held in August, will begin on July 6 and close on July 30. Among the courses arranged may be mentioned that on chemical manufactures intended for teachers of chemistry in technical schools who hold a university degree in chemistry or equivalent qualification; and those on the testing and working of electrical machines, practical mathematics and mechanics, hygiene and sick nursing, experimental science, and rural science (including school gardening). Teachers who attend the courses from the beginning to the end are allowed a sum of 3*l.* 10*s.* towards their expenses while living at the centre; and those who travel more than twenty miles to the centre of instruction are allowed, in addition, third-class railway fare for one return journey from the railway station nearest their school.

The metallurgy laboratory for the mechanical testing of metals and alloys, presented to the Sir John Cass Technical Institute by the Worshipful Company of Goldsmiths, was formally opened by Sir Boverton Redwood, Senior Warden of the Goldsmiths' Company, on March 3, in the unavoidable absence owing to illness of Sir Robert Mowbray, Prime Warden of the company. The work of this new laboratory, which will form an important extension of the metallurgy department of the institute, will be carried on from the metallurgical rather than from the engineering point of view, and will be closely related to the instruction already provided in connection with the metallographic and pyrometric examination of metals and alloys, including iron and steel and the materials used in the motor-car industry and in the construction of aeroplanes, high-speed machinery, and the like. Previous to the opening of the laboratory, Sir Boverton Redwood distributed the prizes gained by students of the institute during the past session, and delivered an address, the chair being taken by Sir Thomas Elliott, who has succeeded the late Sir Owen Roberts as chairman of the governing body. In speaking of the work of the institute, Sir Boverton Redwood said that such work as is being done was never more needed than at the present time. Among other things which the war has done for us, it has shown us that there must be a much more intimate relation between science and industry in this country; and it is to be hoped that the students will avail themselves to the fullest possible extent of the facilities which the institute affords them of becoming better qualified to discharge the duties with which they will be entrusted. If one result of the war is to bring about a better recognition of what is needed in this direction we shall have some compensation for the sacrifices which we are making. In referring to the courses on fuel and power, arranged at the institute, Sir Boverton pointed out the all-important part that is now being played by liquid fuel both in the Navy and on the field of battle on land, especially in connection with the "all-oil boilers" now in use on the battleships of the *Queen Elizabeth* class, all of which are driven solely by oil fuel.

SOCIETIES AND ACADEMIES.

London.

Geological Society, February 19. Annual General Meeting.—Dr. A. Smith Woodward, president, in the chair.—Dr. A. **Smith Woodward**: Presidential Address. The progress of geology depends on so many lines of research, that each specialist does well at times to pause and consider the relation of his own small part to the whole. The president therefore reviewed some results of his study of fossil fishes in their bearing on stratigraphy. However necessary detailed lists of species of fossils might be for comparative work with sediments in restricted areas, he hoped to show that in dealing with broader questions names were really of small importance. Certain general principles had been arrived at, which would serve for all practical purposes. Each successive great group of fishes began with free-swimming fusiform animals, of which some passed quickly into slow-moving or grovelling types, while others changed more gradually into elongated or eel-shaped types. There was also a constant tendency for the primitive symmetry of the parts of the skeleton in successive members of a group to become marred by various more or less irregular fusions, subdivisions, and suppressions. Some of the successive species of each group increased in size, until the maximum was reached just before the time for extinction. These and many other more special inevitable changes had now been traced in most groups, and the various geological dates at which they occurred had been determined by observations on fossil fishes from many parts of the world. Even fragments of fish-skeletons, too imperfect to be named, were often therefore of value for stratigraphical purposes.

Royal Anthropological Institute, February 23.—C. **Dawson**: Flint implement cultures of the Sussex Ouse Valley, with special reference to the Piltdown gravel-spreads and deposits. Among the exhibits were originals and casts of the rude iron-stained Palæolithic implements discovered at Piltdown. They are really large flakes worked on one face, rather after the Chellean culture. The other face is unworked, like those from the Mousterian cultures. The large elephant-bone implement trimmed to a point like a stake at one end, and roughly rounded by cuts at the other end, was exhibited. By comparison it is found that this implement is made from one of the thigh-bones of a large species of elephant not yet discovered later than Late Pliocene or Early Pleistocene ages. Mr. Dawson specially dealt with the "columnar" or "prismatic" flints of which the gravel-spreads of the neighbourhood is mainly composed. Among these flints have been discovered many of the Eolithic type forms and some *rostro-carinate* varieties.

Zoological Society, February 23.—Prof. E. W. MacBride, vice-president, in the chair.—Miss Kathleen **Haddon**: The methods of feeding and the mouth-parts of the larva of the glow-worm. External digestion is a phenomenon of fairly wide occurrence among various groups of insects, and the mouth-parts are in some cases specially adapted to this purpose. The larva of the glow-worm (*Lampyris noctiluca*) feeds on snails, of which it leaves no residue but an empty shell; it is unlikely that there is any preliminary anæsthetising as asserted by Fabre. The mandibles of the larva bite up the food and each mandible is pierced by a fine tube, through which a dark-coloured fluid is exuded. The bases of all the mouth-parts are covered with fine outwardly directed hairs, which are bathed in the juices of the snail whilst the larva is feeding; the juice is sucked into the œsophagus, which is extremely narrow, by the action of a pharyngeal pump similar to that found in other sucking insects.—Dr. J. F. **Gemmill**: Ciliation of asterids and the question of ciliary nutrition in certain species. The arrangement of the ciliary currents on the various surfaces of four widely different species of starfishes is described in detail. This arrangement is constant for all individuals in each of the species, and, except as regards external surfaces, is practically the same in all the species. Everywhere the arrangement is shown to be explicable by physiological needs. Ciliation in the perihæmal spaces is demonstrated.—R. E. **Turner**: New fossorial wasps. The wasps were mostly collected while on a recent expedition to Australia, but include a few received from the Queensland and West Australian Museums.—Lt.-Col. J. M. **Fawcett**: A collection of Heterocera made by Mr. W. Feather in British East Africa. The bulk of the species was taken at light during damp evenings, and perhaps the most interesting capture is that of a specimen of the celebrated *Actias besanti*, Rebel, a large and most beautiful Saturnid moth distinguished by its extremely long tails. This is a well-known rarity of the "first water," and only four specimens were previously known to have been taken, two of which are in the British Museum and two in Germany. Besides the forms described as new species, there are a good many previously described forms not as yet represented in the National Collection, which of itself is evidence of their rarity. Mr. Feather is to be especially congratulated upon the very perfect condition of his specimens and the very accurate record he has kept of the dates of their capture and the localities. Many of the forms dealt with in this memoir were only previously known to science through specimens brought from tropical West Africa, and were previously unrecorded from British East Africa. But this region still remains to be properly worked out, and a great field of research is in store for anyone who can find time to take the matter in hand.

CAMBRIDGE.

Philosophical Society, February 22.—Prof. Newall, president, in the chair.—Dr. **Arber** and R. H. **Goode**: Some fossil plants from the Devonian rocks of North Devon. In addition to the first record of an obscure plant specimen from the Lynton beds, some six other types are described from the Baggy or Cucullæa beds of the Upper Devonian. One of these, Xenotheca, is an entirely new fructification, consisting of thecæ with eight teeth, terminating the branches of a dichotomously branched axis. These thecæ are regarded as being probably of the nature of cupules. *Sphenopteridium rigidum*, Ludw., is recorded for the first time from Britain. The other fossils can only be identified generically as Sphenopteris sp., Telangium sp., Knorria sp., and Cordaites? sp. These are the oldest (in a geological sense) fossil plants of terrestrial habit yet known from England.—H. Hamshaw **Thomas**: Some new and rare Jurassic plants from Yorkshire—the male flower of *Williamsonia gigas*, L. and H. The female strobili of this species were described many years ago, but the male sporophylls have remained a matter for speculation. When examining the specimens in the Yates Collection in the Museum of Natural History at Paris, the author found an example showing an undoubted male flower of the same general type as *Williamsonia spectabilis*, Nath. Though not attached, there were strong reasons for regarding it as belonging to the species *W. gigas*. The flower was briefly described, and compared with other species in the genus.—Dr. C. E. **Moss**: Nomenclature of *Pteris aquilina*.

DUBLIN.

Royal Irish Academy, February 22.—Count Plunkett in the chair.—J. A. **McClelland** and J. J. **Dowling**: Some electrical properties of powders in thin layers. A very thin layer of a conducting powder, such as graphite, is formed on the surface of an insulator, usually paraffin. Tinfoil strips a few centimetres apart are fastened on the layer so as to make good electrical connection with it, and the conductivity of the layer measured. The strips being earthed, a high potential is applied to a plate parallel to the layer, a few millimetres of paraffin intervening between the plate and the layer. The conductivity of the layer is then found to be very much increased. The points of resemblance and of difference between this effect and the coherer effect are discussed in the paper, and the laws obeyed by the conductivity are studied in detail.

PARIS.

Academy of Sciences, March 1.—M. Ed. Perrier in the chair.—The President announced the deaths of George William Hill and G. F. J. Auwers, correspondants in the section of astronomy.—E. L. **Bouvier**: The adaptative forms of *Scyllarus arctus* and the post-larval development of Scyllarus.—Haton de la **Goupillière**: The sums of like powers of integral numbers.—J. **Guillaume**: Observations of the Mellish comet made at the Observatory at Lyons. Six positions given for February 20, 23, 25, and 26. The comet appeared as a circular nebulosity, diameter about half a minute of arc, with faintly marked excentric nucleus. Was about the 11th magnitude.—M. **Coggia**: Observations of the Mellish comet made at the Marseilles Observatory. Positions given for February 20, 23, and 25. W. **Sierpinski**: A curve of which any point is a point of ramification.—André **Brochet**: The catalytic reduction of indigo. In slightly alkaline solution indigo is rapidly reduced by hydrogen in presence of suspended metallic nickel. The indigo white obtained has the advantage of being free from saline impurities.—J. **Caralp**: A Permian melaphyre in the Ariège Pyrenees.—Marin **Molliard**: Free nitrogen and the higher plants. Experiments are described proving that the radish, grown aseptically, is incapable of assimilating atmospheric nitrogen.—Georges A. Le **Roy**: The use of low temperatures in toxicological analysis. The fine subdivision of tissues is facilitated by a preliminary solidification by freezing.

BOOKS RECEIVED.

The Carnegie United Kingdom Trust. First Annual Report. Pp. 34. (Edinburgh: T. and A. Constable.)

Memoirs of the Geological Survey of India. Palæontologia Indica. Vol. v. Memoir No. 2. The Anthracolithic Faunæ of Kashmir, Kanaur, and Spiti. By Dr. C. Diener. Pp. 135+plates xi. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.)

Twenty-seventh Annual Report of the Purdue University Agricultural Experiment Station, Lafayette, Indiana. Pp. 88. (Lafayette: Haywood Publishing Co.)

Clark University, Worcester, Mass. Register and Twenty-seventh Official Announcement. Pp. 112. (Worcester, Mass.: Clark University.)

Memoirs of the Geological Survey, Scotland. Explanation of Sheet 74. The Geology of Mid-Strathspey and Strathdearn. By L. W. Hinxman and E. M. Anderson. Pp. v+97. (London: H.M.S.O.; E. Stanford, Ltd.) 2*s*. 6*d*.

Memoirs of the Geological Survey, England and Wales. Explanation of Sheet 269. The Geology of the Country around Windsor and Chertsey. By A. Dewey and C. E. N. Bromehead. Pp. vi+123. (London: H.M.S.O.; E. Stanford, Ltd. 2*s*. 6*d*.

DIARY OF SOCIETIES.

THURSDAY, March 11.

Royal Society, at 4.30.—Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera: E. Heron-Allen.—The Occurrence of an Intracranial Ganglion upon the Oculomotor Nerve in Scyllium Canicula, with a suggestion as to its Bearing upon the question of the Segmental Value of certain of the Cranial Nerves: G. E. Nicholls.—Experiments on the Restoration of Paralysed Muscles by Means of Nerve Anastomosis. III.—Anastomosis of the Brachial Plexus, with a consideration of the Distribution of its Roots: Prof. R. Kennedy.—On the Mechanism of the Cardiac Valves. A Preliminary Communication: A. F. S. Kent.

Institution of Electrical Engineers, at 8.—Electric Cooking, mainly from the Consumer's Point of View: W. R. Cooper.

Child Study Society, at 6.—*Discussion:* The Care and Development of the Child—during School Age—Treatment Centres and their Possibilities: Miss Margaret McMillan.—Care Committees: Mrs. Evelyn.

FRIDAY, March 12.

Royal Institution, at 9.—Back to Lister: Sir R. J. Godlee.

Physical Society, at 8.—(1) The Estimation of High Temperatures by the Method of Colour Identity: (2) The Unit of Candle-power in White Light: C. C. Paterson and B. P. Dudding.—The Relative Losses in Dielectrics in Equivalent Electric Fields, Steady and Alternating (R.M.S.): G. L. Addenbrooke.

Malacological Society, at 8.—*Helicella crayfordensis*, n.sp. from the Pleistocene deposits of S.E. England: A. S. Kennard and B. B. Woodward.—Further Notes on Radulæ: the Rev. E. W. Bowell.—The Editions of Swainson's "Exotic Conchology": A. Reynell.

Royal Astronomical Society, at 5.—Double Stars Measured at the Cape: J. Voûte.—Comet Westland: E. H. Beattie.—A General Solution of Hill's Equation: E. Lindsay Ince.—Note on the Comparison of Two Plates of the Same Region in the Vatican Zones of the Astrographic Catalogue: Ethel F. Bellamy.—*Probable Papers:* The Dynamics of a Globular Stellar System. II.: A. S. Eddington.—The Secular Acceleration of the Moon's Mean Motion, as Determined from the Occultations in the Almagest: J. K. Fotheringham and Gertrude Longbottom.—Micrometrical Measures of Double Stars made in 1914: Rev. T. E. R. Phillips.

SATURDAY, March 13.

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

MONDAY, March 15.

Aristotelian Society, at 8.—The Philosophy of Values: Dr Tudor Jones.

Victoria Institute, at 4.30.—The Determination of Easter Day: Dr. A. M. W. Downing.

Royal Society of Arts, at 8.—House Building: M. H. Baillie Scott.

TUESDAY, March 16.

Royal Institution, at 3.—The Belief in Immortality among the Polynesians Sir J. G. Frazer.

Royal Statistical Society, at 5.15.—The Cost of the War: E. Crammond.

Illuminating Engineering Society at 8.—*Discussion:* The Marking and Rating of Lamps and the best methods of specifying their Illuminating Value.

Mineralogical Society, at 5.15.—The Dispersion of Adularia from St. Gothard, Felspar from Madagascar, and Moonstone from Ceylon: Dr. S. Kôzu.—The Meteoric Stone of Launton, Oxfordshire: Dr. G. T. Prior.

WEDNESDAY, March 17.

Institution of Electrical Engineers, at 7.45.—Students' Section Some Experiments on the Induction Generator: W. H. Date.

Royal Society of Arts, at 8.—The Industrial Uses of Coal Gas: H. M. Thornton.

Royal Meteorological Society, at 7.30.—The Meteorology of the Sun: Dr. W. Geoffrey Duffield.

Entomological Society, at 8.

Royal Microscopical Society, at 8.—A New Mitotic Structure Disclosed as the Result of New Technique: E. J. Sheppard.—Notes on the Structure of Tests of Fresh-water Rhizopoda: G. H. Wailes.

THURSDAY, March 18.

Royal Society, at 4.30.—Bakerian Lecture: X-rays and Crystals: Prof. W. H. Bragg.

Royal Institution, at 3.—The Form and Structure of the London Basin: Dr. A. Strahan.

Royal Society of Arts, at 4.30.—The Indian Army: Lieut.-Colonel A. C. Yate.

Institution of Mining and Metallurgy, at 8.—Annual Meeting.

FRIDAY, March 19.

Royal Institution, at 9.—The Modern Piano Player—Scientific Aspects: Prof. G. H. Bryan.

Institution of Mechanical Engineers, at 8.—The Chemical and Mechanical Relations of Iron, Cobalt, and Carbon: Prof. J. O. Arnold and Prof. A. A. Read.

SATURDAY, March 20.

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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THURSDAY, MARCH 18, 1915.

SCIENCE AND INDUSTRY.

WHATEVER the political changes resulting from the present European struggle may be, it is certain that the industrial and economic changes will be of an equally striking and revolutionary character. Those of us who can remember Europe as it was before the war of 1870 and now look back upon the forty-five years which have elapsed since that fateful conflict, cannot fail to realise that the transfer of Alsace and Lorraine from France to Germany was an event of vanishing importance compared with the gigantic disturbance which has been brought about in Europe and throughout the world by the unprecedented industrial expansion of Germany which has taken place during the same period. Some idea of the stupendous magnitude of this rapid development in the matter of chemical industries may be gathered from the figures cited by Prof. Percy Frankland in a lecture recently delivered before the Society of Chemical Industry, and of which an abstract was published in our last issue. The magnitude and variety of the German chemical industries are surpassed in wonder only by the rapidity with which they have developed from the very small dimensions which they possessed prior to the war of 1870. Still more remarkable, however, is the fact that a similar investigation of many other activities, such as the textile, mining, metallurgical, electrical, agricultural, and shipping industries, would reveal developments almost equally startling.

It is this great industrial prosperity which has rendered possible the vast and amazing effort to secure German supremacy in Europe of which we are the spectators to-day. The older ruling class in Germany had but little interest in commerce and industry as such but it had the sagacity to see that its dreams of empire could only be realised by fostering industrial and commercial enterprise in every possible way. The ruling class, at bottom despising the tradesman in every shape and form, has had the wisdom to recognise that its prejudices must be concealed, and that everything must be done to put the wealth-producing classes into the most favourable position for competing with the similar classes of rival countries. The rulers of Germany had the discernment to apprehend that one of the most important weapons in that competition was education, and that education must not be of a uniform, stereotyped, and antiquated pattern, but must be elastic and carefully adapted to the needs of each particular class of the community. Education of every kind has been promoted, not only by pecuniary endowment but by the granting of exceptional privileges, both material and social, to those possessing attainments of a higher order, *e.g.*, by the reduction of military service to a period of one year only in the case of all boys who have passed beyond a certain school standard. Research of every description, not only in science but in every other branch of learning, has been fostered to an extent quite unknown in any other country.

This has resulted in Germany becoming beyond all other countries the land of the expert, "a country of damned professors," as Lord Palmerston once called it in the language of a bygone day. It is the country in which every man is proud of knowing his own particular business, nor will he be listened to on any other subject. In England, if a man succeeds in catching the public ear, his utterances on every conceivable subject will be accepted by thousands. Nothing is more astounding than the faith which large sections of people put in the omniscience of our prominent men. We can well remember how Mr. Gladstone, who had adopted the plan of replying by post-card to his innumerable inquirers, was once not only asked for his opinion on the efficacy of vaccination, but actually thought fit to express it. Other and much more recent examples of the faith reposed in self-constituted oracles amongst us will occur to most of the readers of NATURE. In Germany knowledge is so widely diffused, and it is so generally understood that real knowledge can only be attained by years devoted to some kind of research, using the word in its widest sense, that most educated Germans are aware that any given individual, however brilliant, can only be an authority in a comparatively limited field of knowledge. In Germany, therefore, it is only the opinion of the accepted expert that counts. If Germany is the land of experts, England is undoubtedly the land of amateurs, and, owing to the extraordinary genius of our countrymen, it is quite true that in the past most striking achievements must be credited to amateurs. Priestley and Cavendish were amateurs, as were Darwin and many others of high distinction that could be mentioned, but they assuredly became experts also in fact, if not in name.

Science is the dynamic and creative force in industry, and it is only through scientific discovery that industry can rapidly advance. It is this fact which has been freely recognised in Germany, whereas it is from this fact that the great majority of Englishmen instinctively shrink. The German believes in shaping his practice on theory, whilst the Englishman moulds his practice on tradition and instinct, and avoids all theoretical considerations as far as he can. In the earlier stages of chemical industry, and whilst chemical science was in a rudimentary state, much was accomplished by the eminently practical instincts of Englishmen, but with the increasing complexity and refinement of the problems involved, progress has only become possible through profound knowledge gained by unceasing investigation directed by theoretical considerations, and it has been during this later phase that such rapid strides have been made by the chemical manufacturers of Germany.

Of all the chemical industries, the one which depends most entirely on a far-reaching knowledge of chemical theory is that of Synthetic Organic Products (Artificial Dyes, Drugs, Perfumes, etc.), for it would certainly require instincts of even a super-British order to be capable of devising methods for the economic manufacture of such commodities as indigo, adrenalin, and ionone! It is not surprising, therefore, that this branch of chemical industry is almost entirely in German hands, whilst the other branches are, for the most part, gravitating in the same direction.

It is not the unexpected which has happened, for that the neglect of science by our manufacturers would inevitably lead to this result has been consistently preached by British chemists during the past forty years. The irony of the situation lies in the fact that this relative failure of our chemical industries to expand has gone on *pari passu* with a great increase in our output of chemical research, the quality of some of which has been of a particularly brilliant kind. That this capacity for research has remained almost wholly divorced from industry is due to the British manufacturer, who has almost entirely failed to attract into his works the more brilliant chemists trained in this country. The remuneration and prospects offered are in general of such a disadvantageous character that they cannot be entertained excepting as a last resort. It is, moreover, the absence of any prospect of reasonable remuneration in industrial chemistry that greatly limits the study of chemistry as a profession in this country. The Government and the municipal corporations, in their capacity as employers of chemists, are no better than the manufacturers.

That the British manufacturer is himself in general entirely ignorant of chemistry is the result of our antiquated system of education. Whatever school he may have attended will almost certainly have been presided over by a headmaster reared in traditions of medievalism, with the result that he probably imbibed the idea that the study of science would relegate him to an inferior position in the school; at the university, unless he were reading either classics or mathematics, he would not, even at the present day, be in the swim, and would find little or no favour with the head of his college, whilst until recently he would have been of no account at all. He would then pass into his hereditary position in the factory knowing nothing of the science upon which the business is based, and incapable of understanding even the alphabet of the language of the chemical officers it may possess. What wonder, then, that he distrusts and fears these chemists, who are the brain of his business, and that he prefers to confide in the engineers, who are but little less ignorant of chemistry than himself.

That this is the typical situation in the chemical industries of this country was revealed in a particularly significant manner in the House of Commons only a few nights ago, when the Government scheme of "British Dyes, Limited," was under discussion. At the conclusion of the debate, the Parliamentary Secretary of the Board of Trade said that the man who was conversant with the science and practice of dye manufacture was unfit to go on the directorate, because, as he would know something of the business, the whole of the other directors, being but business men, would be in his hands. We are thus authoritatively informed, from his seat in Parliament, by the Secretary of the very Board which is entrusted with the duty to look after the commercial and industrial interests of the country, that the first qualification of a director of a public company subsidised by the Government is that he must know nothing of the business in which that company proposes to engage. Surely the report of this speech must have escaped the astigmatic eye of the official censor, or he would have passed his pencil over a piece of information so gratifying and useful to the enemy! As Prof. Armstrong, in commenting on this utterance in a letter to the *Morning Post* on Saturday last, very truly remarks: "Our fate as makers of dyes is sealed. We, the taxpayers, can do nothing but look on while our million and a half is squandered by directors who now confessedly are to be men without business knowledge of the industry they control."

If we would take advantage of the great opportunity which this war affords for industrial and economic rearrangements, it is imperative that the ruling classes in this country should no longer continue in their present state of semi-education which passes as culture, and which permits them to go through life with little or no understanding of the vital importance of science to the State. If after the war we are to recover some of the chemical industries which we have lost, and even maintain those which we still possess, it is essential that the individual undertakings should be controlled by men who have a real and expert knowledge of the business in which they are engaged, and that our legislators should have had sufficient scientific education to enable them to understand such problems connected with these industries as may be brought before them. The experience of the past thirty years points unmistakably to the conclusion that industrial success is becoming more and more dependent upon the co-ordination of industrial effort, and the embarrassing position in which we find ourselves at the present moment, in respect of the supply of a number of chemical products, is largely attributable to the almost entire absence of any such organisation. In both France and Germany we understand that councils of experts have been appointed to inquire into the effects of the war on the chemical industries of these countries, and to report to their respective Governments as to what legislative measures are desirable for promoting their welfare. As the present crisis is on a scale which we trust may never recur in the history of the world, so the opportunity for discarding mischievous traditions, effete ideas, and clumsy methods of procedure is of such an altogether exceptional character that it is to be hoped we shall not allow it to pass unutilised through ignorance, lethargy, or divided counsels.

THE CHEMISTRY OF FOOD PRODUCTS.

Food Products. By Prof. H. C. Sherman. Pp. ix + 594. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 10*s*. net.

APART from the analytical side, chemistry in its application to food products is a neglected science in this country in comparison with the activity which exists in America. The neglect, however, has been, in the main, in official and public circles, as several of the British food manufacturers of repute have availed themselves of scientific help for some years past, and it may be claimed that the high—not to say world-wide—repute of the products of some of these firms is to some extent due to the resource of, as well as the control exercised by, their scientific staff. In the United States, legislation has been very largely the cause of the awakening of the public interest in its food, and in this connection the name of Dr. H. W. Wiley will be remembered with gratitude by present and future generations. Whatever the cause, the development of the investigation of the composition and value of food products has been exceptionally rapid during the past few years: it is manifested by such outward signs as the foundation of university chairs in food chemistry in America, and the publication of informative text-books.

As the moment is ripe for reform, the wisdom of founding such a chair at our own Imperial College of Technology may be urged: there is much to be done, for example, in educating the public as to the food value of many low-priced products from our Colonial Empire, which are at present neglected, and in showing manfacturers how to make better use of the available raw material.

Dr. H. C. Sherman, who occupies the chair of food chemistry at Columbia University, has produced an exceptionally informative book, in which he combines an account of the production and preparation of the various food products for the market, with statistical data, details as to their chemistry and physiology, and an outline of the latest scientific research and opinions.

The book also contains a large number of up-to-date tables giving the food values, protein content, and mineral constituents of all sorts of foods, and is, indeed, replete with information of every kind, so that it will be indispensable to every food chemist and manufacturer. All the principal food products are dealt with in turn, each chapter being concluded with a list of references to the literature. Though much of the information given is outside the ordinary scope of the college trained chemist, it corresponds exactly with the practical details which the actual worker requires, and we do not remember to have seen this given so succinctly anywhere else. The more advanced scientific sections are equally satisfactory, so that current views are expressed without undue dogmatism: this is especially the case in the more physiological sections.

A good deal of space is devoted both in an appendix and elsewhere to the rules and regulations for the enforcement of the Foods and Drugs

Act in America. These are of great interest to the British reader in view of the possibility of more drastic food legislation here, though fortunately the sale of inferior food materials is not tolerated to anything like the extent that existed in America. It is commonly understood that the most drastic legislation was necessary there to combat the existing evils, although its severity has to some extent acted in restriction of trade. In any case, such movement here should be official and under the guidance of responsible scientific opinion, and not sponsored by irresponsible "Pure Food Institutions."

The university courses of study are already so crowded that there is no time for the introduction of food chemistry into the degree course, nor, indeed, is such desirable. The would-be chemist, if he is to play his part in building up British industries, must be trained as a chemist first and as a specialist afterwards. Books such as this will be of the utmost service at the stage when the young chemist has to act on his own and to take responsibility. Prof. Sherman has done a great service to his colleagues. From the point of view here developed it is to be hoped that he will compress rather than enlarge future editions, so that the book may be read and not consulted as a dictionary. E. F. A.

APPLIED BOTANY.

(1) *A Text-book of Grasses, with Especial Reference to the Economic Species of the United States.* By Prof. A. S. Hitchcock. Pp. xvii+276. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 6*s*. 6*d*. net.

(2) *A Manual of Weeds.* By A. E. Georgia. Pp. xi+593. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s*. 6*d*. net.

(1) ALTHOUGH we are disposed to welcome any innovation in the planning of text-books of applied science, we cannot congratulate the author of the work under review on the scheme which he has adopted. He divides his book into two parts, and treats first of economic agrostology, and subsequently, of systematic agrostology. As a consequence, the student who begins the book at the beginning reads of a considerable number of grasses, mostly called by their popular names, and if he be a novice, he must pause at each page to look up, in the systematic part, what these names signify. Moreover, whether he be novice or adept, he will find but little information of real value in the economic section. He will discover how much corn and wheat and barley and other cereals is grown in the United States, and how much each of these crops is worth; that America eats wheaten bread, and that the inhabitants of the "Old World" subsist on wheat, corn, and rice. Beside some useful general information, he will find a chapter on lawns, and a page or two on sand-binding grasses.

It may be that this somewhat discursive treatment is all that is possible in the present stage of "economic agrostology"; but whether it be so or no, we feel convinced that the proper place for it is at the end and not at the beginning of the volume.

Part ii. opens with an account of the morphology of the vegetative and floral organs of grasses. The descriptions are terse and clear, but their value is reduced very materially by the fact that not one figure is given by way of illustration, neither of the vegetative organs nor of the somewhat difficult inflorescence and flower. This is the more remarkable in that the succeeding taxonomic chapters are well and copiously illustrated.

The experience of the reviewer convinces him that it is impossible to teach the systematic botany of grasses unless the student has first mastered thoroughly the floral morphology of typical forms, and doubt may be expressed whether such mastering may be obtained by merely following the written text.

The taxonomical section, which occupies nearly half the book, follows in part the classification adopted by Bentham and Hooker, and, with respect to the "tribes," that of Hackel. The code governing nomenclature is not that laid down in the Vienna rules, but is "The American Code of Botanical Nomenclature." To criticise this decision scarcely becomes a non-American reviewer, but he may express a regret that systematists cannot come to a general agreement which will prevent these games of nine-pins with names. For example, all the gardens of Europe know Pampas grass by the name *Gynerium argenteum*. In this book it is called *Cortaderia argentea,* and no indication is given whether *Gynerium argenteum* is synonymous with *C. argentea,* or whether the latter is another plant under the same common name. Buffon said long ago that it was easier to learn botany than botanical nomenclature. The systematists seem to take a joy in maintaining the truth of the aphorism.

(2) M. Boutroux has insisted recently that sentiment no less than will and intellect must be reckoned with in the psychological make-up of mankind. No one who has fought with weeds, whether in the farm, the garden, or the golf-green will doubt it. The fight was stubborn and its fortunes varied, but whether won or lost, the

weeder left the field with a deep respect for his adversaries: so stubborn is the resistance that they offer, so various are the means by which they evade extermination.

Here they all are, hundreds of them catalogued and described in this book, and although the weeds treated of are those which trouble the American cultivator, the English farmer and gardener will recognise many of his old foes. He will also learn not a little of new ways of fighting them. For America takes its weeds seriously—more seriously even than the good farmer of this country. He tracks them to their lairs in the hedgerows and keeps a sharp look-out on them in his neighbours' plots. He even invokes legislation upon them. He needs be vigilant indeed, for field labour is not cheap or plentiful in his country, and the chief means of combating weeds—constant cultivation—cannot always be practised. We confess to a certain feeling of unmalicious pleasure, like that we have in the misfortunes of our friends, when we saw the weediness of the fields of certain parts of North America. Nevertheless, the American will win in his fight with weeds; for he threatens them with all the resources of organic chemistry. Not only are the sulphates of iron and of copper pressed into his service as weed-killers; but, and more recently, weeds are being attacked with fine sprays of kerosene or crude petroleum.

The author of this manual writes with sureness on her subject. She knows weeds well, describes them admirably, and gives much sound advice on the methods to be adopted for their eradication. In fact, this is the best book yet published on weeds and one that will prove of considerable service to cultivators in this country. High praise must be given also to F. Schuyler Mathews for the excellence of the 385 illustrations. Their value is enhanced by the fact that they face the page of text on which they are severally described.

One suggestion only would we offer in the interest of the busy reader of the book: that a new edition should include an appendix in which the means of control, and weeds controlled by these means, are classified.

LANTERN- AND MICRO-PROJECTION.

Optic Projection Principles, Installation and Use of the Magic Lantern, Projection Microscope, Reflecting Lantern, Moving Picture Machine. By Prof. S. H. Gage and Dr. H. P. Gage. Pp. ix+731. (Ithaca, N.Y.: Comstock Publishing Co., 1914.) Price 3.00 dollars.

THE use of the lantern in one of its many forms has become more and more general. In our younger days it was a great and exceptional treat to see a magic lantern entertainment, but now there are kinematograph theatres in all our main streets, and lanterns for the teaching of history, geography, and science in our schools, so that the younger generation look upon the lantern as a matter of course, and even the poorest of them go (perhaps too frequently) to the picture palaces.

The number of operators using the lantern has thus enormously increased in the last few years, and the lantern is acquiring quite a literature of its own. The volume under review treats the subject very fully, and collects into one volume a large amount of valuable information on every aspect of the subject. It is intended to be available to the ordinary unscientific rule-of-thumb operator, as well as to the manufacturer, and to the unscientific demonstrator or student. To meet the needs of the first of these, plain, practical directions are given in the earlier part of the book for using the direct-current arc, the alternating arc, the miniature arc, the lime-light, etc.; also practical summaries of what to do and what to avoid are added to each chapter, and there are similar practical instructions for using sunlight with a heliostat, for projecting opaque objects, for micro-projection, the kinematograph, and many other applications of the lantern. Presumably with the idea of making each section complete in itself, there is a great deal of repetition in these chapters. This will probably be of advantage to the practical man who is interested only in one form of projection, but it makes this part of the book tedious to read.

In the later part of the book there are many valuable tables and curves giving, for instance, the relations between current, voltage, and candle-power of the different forms of arcs and their distribution of light intensity; also the light and the energy absorption of the various media—glass, water, etc.—that are used in projection apparatus; and the reflecting powers and light distribution of lantern screens.

In the last chapter are some applications to physics. We should like to have seen this further developed; brief as it is, it explains how to demonstrate some beautiful experiments in advanced optics—experiments which are not often shown.

The instructions for adjusting the radiant are somewhat misleading. It is said that it should be placed at the principal focus of the first section of the condenser (§ 55), and it is said that there is a loss of light if the lamp is brought nearer. In almost every case this is not so, a bigger cone of light being embraced; in practice the second lens of the condenser is not made a weak lens, but the lamp is pushed up within the focus of the first lens, and it is very rarely that an operator changes his condenser when he changes his objective, as laid down in § 89.

The only other criticism is that in projecting the rings and brushes in convergent polarised light, the objective does not focus the back *lens* of the second convergent system on the screen, but its back *focal plane*; this mistake is, however, generally made in the optical text-books.

It should be added that there is a useful bibliography and a copious index.

MATHEMATICAL WORKS.

(1) *Elements of Geometry.* By S. Barnard and J. M. Child. Parts i.–vi. Pp. ix + 465. (London: Macmillan and Co., Ltd., 1914.) Price 4*s.* 6*d.*

(2) *A Foundational Study in the Pedagogy of Arithmetic.* By Dr. H. B. Howell. xi + 328. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s.* 6*d.* net.

(3) *Constructive Text-book of Practical Mathematics.* By H. W. Marsh. Volume iii. Technical Geometry. Pp. xiv + 244. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s.* 6*d.* net.

(4) *Algebraic Invariants.* By Prof. L. E. Dickson. Pp. x + 100. (New York: J. Wiley and Sons, Inc.; London, Chapman and Hall, Ltd., 1914.) Price 5*s.* 6*d.* net.

(5) *Plane Trigonometry and Tables.* By G. Wentworth and D. E. Smith. Pp. v + 188. *Trigonometric and Logarithmic Tables.* By G. Wentworth and D. E. Smith. Pp. v + 104. (London: Ginn and Co., 1914.) Price 5*s.*

(1) THIS is not a modified edition of the authors' well-known text-book entitled "A New Geometry for Schools." In form, grouping, method, and to some extent, subject-matter, it differs widely from their former work. The experience gained from eleven years' teaching on modern lines has led them to certain conclusions which they embody in the present volume. To some extent, they revert to older methods, as, for example, in the treatment of parallels, tangents, the early theorems of the second book of Euclid, and the grouping of cognate theorems. In other respects they adopt a more radical position by introducing trigonometrical ratios and sections on solid geometry (mainly numerical) at an early stage. They have compressed an immense amount of matter into a compact form, and the array of numerical and theoretical exercises is almost alarming in its extent.

(2) The science of pedagogy is arousing increasing interest in this country, although, curiously enough, less among those engaged in teaching at our public schools than at primary and other secondary schools. But the literature of the subject has received comparatively few British contributions. The object of the author is, in his own words, to summarise the anthropological, experimental, pedagogical, psychogenetic and phylogenetic resources now available, which bear on the part arithmetic should play in a scientific curriculum. His investigation is fourfold: (1) genetic, (2) psychological, (3) statistical, (4) didactical. Not the least interesting and valuable part of the book is the account of experiments, arranged and conducted by the author on the determination of ability in number apprehension and fundamental processes.

(3) It is strange to pick up a text-book on geometry and fail to find a single diagram before page 150. The explanation lies in the fact that the author believes that each student should, by his own researches, write his own text-book. That such a mode of procedure as is indicated by the plan and structure of this book has been in operation for nearly twenty years is conclusive evidence of the enthusiastic personality of the author: that many teachers, however, could adopt his method seems to us highly improbable. His purpose is to enable each pupil to build up for himself a logical geometrical structure, by the aid of appropriate suggestions made at the right time. The form these are to take and the quality of the work expected of the pupil is set out in great detail. We doubt, however, whether the author will make many converts.

(4) This monograph provides a simple and admirable introduction to the theory of invariants of algebraic forms. It is divided into three parts. The first deals with linear transformation from the point of view of (1) change of axes of reference, (2) projective geometry. Jacobians and Hessians are discussed, the latter in connection with the solution of the cubic and the points of inflexion of a cubic curve. The second treats of algebraic properties, such as weight, annihilators, reciprocity, differential operators, etc. And the concluding section introduces the symbolic notation of Aronhold and Clebsch. Some carefully selected sets of examples are provided.

(5) The form and plan of this text-book indicate that the changes in the teaching of elementary trigonometry have taken place along similar lines on each side of the Atlantic. The practical aspect of the subject is now regarded as requiring chief emphasis in the early stages and the abstract theory is postponed. Considerable space is de-

voted to applications involving only the use of the right-angled triangle; and identities occupy a subordinate position. The final chapter deals with complex quantities, Demoivre's theorem, and applications to analysis. The last hundred pages of the book are taken up with logarithmic and other tables, calculated to five figures. The first-rate quality of the type employed deserves special mention.

OUR BOOKSHELF.

Experimental Studies in Electricity and Magnetism. By F. E. Nipher. Pp. 73. (Philadelphia: P. Blakiston's Son and Co., 1914.) Price 1·25 dollars net.

THIS book consists mainly of descriptions of the author's experimental work, and summarises his reasons for accepting the one-fluid theory of electricity. Photographs of discharges across a spark-gap, and traces on a photographic plate due to discharges over its surface, constitute the major part of the evidence. Much work has been done, and many interesting plates are reproduced, but it is doubtful whether the experiments are quite so conclusive as the author believes. Several novel ideas are introduced, such as the existence of conducting lines or "drainage channels" round the positive or "exhaust" electrode in every kind of discharge, though it might be pointed out that this idea of a well-conducting channel is scarcely compatible with the considerable potential-slope which exists in the positive column of a discharge tube. The suggestion that gravitational attraction is due solely to the "corpuscular nebula" which permeates all matter is also novel; it is used to explain the explosive effect of discharging a Leyden jar through a wire.

Loosely-worded expressions as "the corpuscular nebula is set into a rhythmical vibration" abound, and the phraseology generally is scarcely so precise as that usually found in scientific publications. It is possible that the case made out by the author suffers considerably from the manner in which it is presented, but certainly simpler explanations than those given would seem to suffice for some of the phenomena mentioned. The deflection of a magnetic needle due to a gust of wind might conceivably be due to a magnetic storm produced by the wind, but it would be advisable to see that the oscillation box is hermetically sealed or even evacuated, before accepting the magnetic storm hypothesis!

The Principles and Practice of Judging Live Stock. By Prof. C. W. Gay. Pp. xviii+413. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 6*s.* 6*d.* net.

THIS volume is a very full compendium of all that belongs to a practice which has almost become a fetish in American agricultural colleges. To the student is given a card on which are printed the sections into which a horse, or some other animal, may be divided, and the marks to be awarded to each section. A draught horse, for instance, is divided into forty sections, and, as the marks total to 100, most sections get very small and none very large marks. The marks for some of the most important parts are these, given shortly: hocks, 6; hind cannons, 2; hind fetlocks, 2; hind pasterns, 3; hind feet, 4; hind legs, 4; walk, 6; trot, 4.

Some of us who have tried it would have been exceedingly glad had this volume contained some evidence as to the educative value of the score card, because it may be doubted whether good judges are produced by its use; and because it fails to make sufficient distinction between the good and the supremely good, or the fair and the useless animal. All this, however, is rather a criticism of the system, or at any rate, of the scale of marks.

If the system be admitted good and useful, Prof. Gay's book is also good and useful. It contains good illustrations, descriptions of many breeds, an appendix containing the card marks for different breeds, and much information as to yields of milk, butter, beef, wool, and so on.

J. W.

The Elements of Electro-Plating. By J. T. Sprague. Pp. vii+72. (London: E. F. N. Spon, Ltd., 1914). Price 1*s.* 6*d.* net.

THE publication of this little volume brings home to us the sparseness of literature on the subject of electro-plating. Its publishers have considered it worth while to re-publish, in this form, the intensely practical and well-written chapter dealing with the practice of the electro-deposition of metals which originally appeared in the late Mr. J. T. Sprague's "Electricity: Its Theory, Sources, and Applications." This classic was one of the best books of its kind when originally written, and the chapter on electro-plating was one of the best parts of the book. It is true that it is addressed "rather to experimentalists, students, and general readers" than to those "mainly intent on business considerations," and it is also true that as good electro-plating was done twenty-five years ago as now; yet one cannot but feel that the publishers would have done better to publish a new book than to re-publish an old one when dealing with a practical application of electricity. The reprint bears the new date 1914, and not the date of original publication, but perhaps some of our older readers may be able to make a rough guess at the latter from the clue given by the following passage: "It is impossible to urge too strongly, alike upon the learner and the practical operator, the advantage of keeping in circuit a suitable galvanometer . . . and galvanometers to show current in amperes are now easily obtainable." The book, old as it is, contains valuable directions and recipes, and if, instead of merely reprinting it, the publishers had employed a practical man of to-day to revise and re-write it, they would have deserved our unstinted commendation.

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.*]

Supposed Horn-Sheaths of an Okapi.

Mr. R. Lydekker, F.R.S., lately directed attention in the columns of Nature to a specimen of the okapi sent home by Dr. Christy from the Congo State, which was stated to be provided with corneous sheaths to its horns, resembling those of an antelope. The specimen has been mounted by Mr. Gerrard, of Camden Town, and is still in his workshop, whilst the skull has been purchased by the Royal College of Surgeons. I have been given the opportunity of examining both the mounted skin and the skull. The skull is of an individual of nearly the same size and age as that presented to the Natural History Museum by the late Captain Boyd Alexander, carefully figured under my superintendence with many other skulls of the okapi in the atlas of my "Monograph of the Okapi," published in 1910 by the trustees of the British Museum. With the new skull acquired by the College of Surgeons, and apparently belonging to the same animal as the skin, is a pair of small ossicones, not yet ankylosed to the skull, measuring about 2 in. along the longer side from point to base. They are of the same shape and little shorter than those of Boyd Alexander's specimen. In neither skull is there as yet a tuberculated surface of the frontal bone developed for the attachment of the ossicone. In the Boyd Alexander specimen each ossicone stood up as a projecting cone, and was covered with the hairy skin except for a small area at the free end, where the hair seems to have been rubbed away, or removed in preparing the skin, as may be seen in the mounted specimen in the Natural History Museum. In Major Powell-Cotton's specimen, of which both skin and skeleton are in the museum, each ossicone is longer, slightly compressed from side to side, and claw-like in shape, the point curved downward and backward; and each ossicone rests on a pitted and tuberculated surface of the frontal bone, to which it is closely fitted but not yet ankylosed.

In older specimens, *e.g.* that in Paris and that in Edinburgh, figured in my atlas, there is complete ankylosis of the ossicone with the frontal bone, and a wide extension of its base. The ossicones of the Powell-Cotton specimen are $3\frac{3}{4}$ in. in length, and are closely covered with hairy skin except, for a length of about $\frac{1}{4}$ in., at the tip, which pierces the skin. This "tip" of the okapi's horn, or ossicone (not yet developed in the Boyd Alexander specimen), consists, as I have described in the Proc. Zool. Soc., 1907, of peculiarly dense bony substance, which acquires a bright polished surface, and is sharply marked off like a nipple, by its raised margin from the rest of the bony substance of the ossicone, as seen in all adult specimens, of several of which I have published drawings. It emerges through the skin as a tooth does, when it is said to be "cut."

It is only in their pointed claw-like shape and the penetration of the skin by the hard, tooth-like apex that the okapi's paired ossicones differ from the paired ossicones of the giraffe. It is, however, remarkable that the fœtal giraffe has already before birth two soft hair-covered growths corresponding in position and proportionate size to the paired ossicones of the adult, and that the bony ossicones develop in these soft up-standing structures soon after birth. The young okapi has no such tegumentary growths, and the ossicone makes its appearance when the animal is nearly full grown or completely so as a free button-like ossification lying beneath the integument, which is pushed upwards by it as it grows. The dense emerging point of the okapi's ossicone forms for the animal a very efficient weapon. The giraffe's ossicone never penetrates the skin, but its apex is broad and flat and clothed with a tuft of long black hair. The axis of the okapi's ossicone is not at right angles to the horizontal plane of the skull, but is directed backwards so as to form an angle of 45° with that plane.

Mr. Gerrard tells me that wrapped in the bundle with the skin of Dr. Christy's specimen as received by him were two hollow, bluntly ending corneous horn-sheaths of about $2\frac{1}{2}$ in. in length, which he was led to suppose belonged to the animal. He has mounted these two hollow horn-sheaths on the top of the animal's head over the holes in the skin made in originally clearing it from the ossicones (when the skin was prepared in Africa) which have gone with the skull to the College of Surgeons. These hollow horns do not fit well to the cut skin, and there is no intrinsic evidence forthcoming to justify the association of them with the okapi's skin. They have the appearance of young horn-sheaths of some species of antelope, and show a few ring-like markings on the surface. They taper only slightly from base to tip, and the tips are rounded and blunt. It is, I admit, conceivable that in the early period of its growth before the completion of its ivory-like point and the cutting by it of the skin, the ossicone of the young okapi might develop a temporary corneous sheath to be shed during further growth and replaced by hairy skin. The prongbuck sheds its horn-sheath yearly, and very young cavicorns have been observed to shed a first sheath before acquiring a permanent one. Hence it is not impossible that a temporary corneous sheath should develop from the skin covering the young ossicone of the okapi.

The real question in such a matter is what is the evidence in favour of the unlikely but possible occurrence? The fact that between fifty and a hundred skins and skulls of the okapi have reached Europe in the last twelve years, and that no such horn-sheaths have hitherto been seen or heard of, is important. It is also important to bear in mind that it is quite certain that when once the okapi is full grown and its ossicone is ankylosed to the skull, it is covered by hairy skin like that covering the skull, from which its naked ivory-like point emerges.

The evidence is as follows. Mr. Gerrard tells me that he was led to believe that the small horny sheaths sent with the skin of the okapi actually belonged to the specimen by the fact that when removed from the parcel a label was found tied to them on which was written, "Horns of the Okapi." This would certainly seem to justify Mr. Gerrard in mounting them on the head, as he did.

He has, however, since I saw the specimen, sent me a note just received by him from Dr. Christy. This is headed, "Details of Okapis obtained with numbers of cases and dates of dispatch." It is signed by Dr. Christy, and dated Khartoum, February 10, 1915. It appears that Dr. Christy has been employed on a mission in the Congo State during 1913–14 by the Belgian Government, and that he had forwarded during those years specimens collected by him to Brussels to be sent on to Mr. Gerrard, acting as his agent, in London. Seven specimens of okapi are mentioned in the list before me, and the date of shooting and the name of the ship and route by which they were dispatched are given. Some were sent off in 1913, others in 1914. Mr. Gerrard tells me that only one—the one he has mounted—has reached him in

London. It is impossible to say whether the others arrived in Brussels, and, if so, what has now become of them. Dr. Christy's list is a very interesting one, and I will venture to give extracts from it. The specimens are distinguished by numbers. "No. 507, ♂ juv., not full grown; shot by myself, April 10, 1913. Skin good, skeleton complete." "No. 531, ♂, full grown. Shot by a Congo official, out shooting with me, May 22, 1913. Horns 1¼ in., skin-covered. Skin good, skeleton complete." "No. 686, ♀, big. Shot by myself, October, 25, 1913. Skin good, skeleton complete." "No. 717, ♂, old. Shot by Reid. Skin good; horns and hoofs attached to skin. Skeleton complete. Horns 4 or 5 in. long, and bare at tips." "No. 532, ? ♂. Skin only: from natives." "No. 533, ? ♀. Skin only; from natives." "No. 695, juv., ? sex; half-grown, 1913. Skin dried by natives. Skeleton complete."

In this list it will be observed that nothing is said about "horn-sheaths." It is perfectly certain that, as a sportsman and naturalist acquainted with the okapi, and the only "educated" European who has himself shot the okapi, Dr. Christy would have directed attention in his notes to the presence of "horn-sheaths" if he had discovered such structures to exist.

Only one of the seven specimens mentioned in Dr. Christy's list has come through to London. I have no doubt that it is the specimen No. 531, shot on May 22, 1913, at Mawambi, by a Congo official out shooting with Dr. Christy. The horns (ossicones) are stated definitely to be *skin*-covered. This agrees with my inference from a comparison with the Boyd Alexander specimen and the state of growth of the ossicones. It makes the "horny-sheaths" impossible. The measurement given by Dr. Christy for the horns (ossicones) is 1¼ in. This is their vertical height from base to apex. As they are pyramidal in shape, the measurement along the side of the pyramid from apex to edge of the expanding base, is as given above by me, about 2 in.

I think that Dr. Christy's own notes settle the question against the horny sheaths which it was already really impossible to "fit" satisfactorily to the specimen with which they reached Mr. Gerrard.

As to how this label—with "Horns of the Okapi" written on it—became attached to these little horn-sheaths it is possible to form various conjectures. Perhaps some busy, well-intentioned servant, being told to be sure to see that the little horns (ossicones) were not omitted from the parcel, mistakenly picked up the small horn-sheaths belonging to some antelope skin, left by chance with other skins and skulls in the disorder of packing or preparing a mass of specimens, and conscientiously but erroneously labelled them "Horns of Okapi," and packed them with specimen No. 531, destined to produce astonishment and confusion on arriving two years later in London.

Dr. Christy is to be congratulated on the fine series of specimens of okapi which he obtained and sent to Brussels *en route* for London. We must hope that they may escape destruction or seizure by the enemies of mankind, and eventually yield their contribution to our knowledge of the okapi, especially since among them are the first specimens seen alive and shot by a competent European observer.

March 9. E. RAY LANKESTER.

The Spectra of Hydrogen and Helium.

MR. E. J. EVANS has described recently some interesting experiments on the "4686" and Pickering series, which were obtained from vacuum tubes containing helium from which hydrogen was apparently completely eliminated. Stark has also observed the "4686" line in a vacuum tube showing no trace of the hydrogen lines. The experimental evidence of a helium origin of the lines in question would thus appear to be strong, and Prof. Fowler, from analogy with the enhanced line series of the alkaline earths, has also concluded that the lines are due to helium. According to Dr. Bohr, who first suggested that the lines were due to helium, the series in question owe their origin to the binding of an electron by a helium atom from which two electrons have been removed. Dr. Bohr's theory involves a modified value of Rydberg's constant for these lines, and Prof. J. W. Nicholson, in a letter to NATURE of February 11, has pointed out that it can be put to the test by an accurate measurement of the lines of the "4686" series, from which the value of the constant can be calculated.

Although the spectroscopic evidence is in favour of helium as the origin of the lines, it may be pointed out that this evidence is not conclusive. Although 4686 does not appear in hydrogen in the absence of helium, the same may be said of ultra-violet members of the Balmer series, which do not appear in vacuum tubes containing pure hydrogen, but which make their appearance when helium is present. The difficulty of preparing vacuum tubes free from hydrogen is well known, and the fact that the ordinary hydrogen lines are absent from the spectrum cannot be taken as conclusive evidence that hydrogen is not present. In view of this fact, the writer has conducted experiments to determine the relative mass of the atom from which the "4686" series originates, by measuring the limits of interference of the "4686" line and the lines of helium and hydrogen. The circumstances which control the breadth of spectrum lines have been discussed by Lord Rayleigh in the current number of the *Philosophical Magazine*.

At low pressures the order of interference at which fringes are still visible is proportional to the square root of the atomic weight of the atom from which the radiation originates. It is hoped shortly to publish a full account of the experiments, but the following may be stated as a preliminary result. A vacuum tube containing helium and hydrogen at a low pressure was excited by an induction coil with capacity and a spark-gap in the circuit, the spectrum consisting of helium lines, 4686, and the hydrogen lines. With an interference apparatus giving a suitable difference of path, moderately sharp ring systems can be obtained for all the helium lines, whilst no trace of interference can be detected in the 4686 line or the hydrogen lines.

Further observations are required to determine the exact limits of interference of the 4686 line and the hydrogen lines, but the results indicate that the mass of the atom from which 4686 originates is definitely smaller than that of the atoms concerned in the production of the ordinary helium spectrum.

T. R. MERTON.

University of London, King's College, March 15.

Musical Sand in China.

AMONG the immense mass of ancient Chinese records and manuscripts brought back from the buried cities and caves of ancient Khotan, in Central Asia, and now stored in the British Museum, is one called the Tun-Huang-Lu, a topographical description of part of Khotan itself. This little geography was written in the time of the Tang dynasty, in the seventh century, but probably contains matter from earlier authors.

Among the specially interesting natural phenomena of the country described in the Tun-Huang-Lu is a large sandhill, which at certain times gave forth strange noises, so much so that a temple in its vicinity was entitled the "Thunder Sound Temple."

The geographer, speaking specially of the sandhill, says:—"The hill of sounding sand stretches 80 li east and west and 40 li north and south. It reaches a height of 500 ft. The whole mass is entirely constituted of pure sand. In the height of summer the sand gives out sounds of itself, and if trodden by men or horses, the noise is heard 10 li away. At festivals people clamber up and rush down again in a body, which causes the sand to give a loud rumbling sound like thunder. Yet when you look at it next morning the hill is just as steep as before."

Mr. Lionel Giles, from whose translation of the Tun-Huang-Lu these extracts are made, mentions that this sounding sandhill is referred to in another old Chinese book, the Wu Tai Shih.

JOSEPH OFFORD.

94 Gloucester Road, South Kensington, S.W.

The Green Flash.

I CAN confirm Dr. Schuster's observation of the green flash at sunrise, as in September last I saw a green segment herald the sun as it rose from the sea into a sky which was free from atmospheric glare (see the *Observatory*, December, 1914). Observations had previously been made at sunset, in one of which the eye was unquestionably fatigued, and the green flash was seen upon turning *away* from the sun at the instant after sunset. In a later sunset experiment precautions were taken to prevent retinal fatigue, and again the flash was seen.

My opinion is confirmed by Prof. Porter's experiment that "the reason why doubt has been cast upon records of the green flash is that the colour may arise in two different ways (complementary colour due to retinal fatigue, or dispersion by the atmosphere), and that the observer has not always been careful to avoid retinal fatigue, as was the case in my first (sunset) observation."

My observation, No. 2 (*loc. cit.*), is also in agreement with Dr. Schuster's experience, that with a very red sun no flash is to be seen.

W. GEOFFREY DUFFIELD.

University College, Reading, March 6.

Measurements of Medieval English Femora.

As the Editor of NATURE has insisted upon the great pressure at present upon his space I propose to reply to Dr. Parsons's letter, in the issue of March 11, adequately elsewhere.

KARL PEARSON.

Galton Laboratory, March 15.

THE PRINCIPLE OF SIMILITUDE.

I HAVE often been impressed by the scanty attention paid even by original workers in physics to the great principle of similitude. It happens not infrequently that results in the form of "laws" are put forward as novelties on the basis of elaborate experiments, which might have been predicted *a priori* after a few minutes' consideration. However useful verification may be, whether to solve doubts or to exercise students, this seems to be an inversion of the natural order. One reason for the neglect of the principle may be that, at any rate in its applications to particular cases, it does not much interest mathematicians. On the other hand, engineers, who might make much more use of it than they have done, employ a notation which tends to obscure it. I refer to the manner in which gravity is treated. When the question under consideration depends essentially upon gravity, the symbol of gravity (g) makes no appearance, but when gravity does not enter into the question at all, g obtrudes itself conspicuously.

I have thought that a few examples, chosen almost at random from various fields, may help to direct the attention of workers and teachers to the great importance of the principle. The statement made is brief and in some cases inadequate, but may perhaps suffice for the purpose. Some foreign considerations of a more or less obvious character have been invoked in aid. In using the method practically, two cautions should be borne in mind. First, there is no prospect of determining a numerical coefficient from the principle of similarity alone; it must be found if at all, by further calculation, or experimentally. Secondly, it is necessary as a preliminary step to specify clearly *all* the quantities on which the desired result may reasonably be supposed to depend, after which it may be possible to drop one or more if further consideration shows that in the circumstances they cannot enter. The following, then, are some conclusions, which may be arrived at by this method:—

Geometrical similarity being presupposed here as always, how does the strength of a bridge depend upon the linear dimension and the force of gravity? In order to entail the same strains, the force of gravity must be inversely as the linear dimension. Under a given gravity the larger structure is the weaker.

The velocity of propagation of periodic waves on the surface of deep water is as the square root of the wave-length.

The periodic time of liquid vibration under gravity in a deep cylindrical vessel of any section is as the square root of the linear dimension.

The periodic time of a tuning-fork, or of a Helmholtz resonator, is directly as the linear dimension.

The intensity of light scattered in an otherwise uniform medium from a small particle of different refractive index is inversely as the fourth power of the wave-length.

The resolving power of an object-glass, measured by the reciprocal of the angle with which it can deal, is directly as the diameter and inversely as the wave-length of the light.

The frequency of vibration of a globe of liquid, vibrating in any of its modes under its own gravitation, is independent of the diameter and directly as the square root of the density.

The frequency of vibration of a drop of liquid, vibrating under capillary force, is directly as the square root of the capillary tension and inversely as the square root of the density and as the $1\frac{1}{2}$ power of the diameter.

The time-constant (*i.e.*, the time in which a current falls in the ratio $e:1$) of a linear conducting electric circuit is directly as the inductance and inversely as the resistance, measured in electro-magnetic measure.

The time-constant of circumferential electric currents in an infinite conducting cylinder is as the square of the diameter.

In a gaseous medium, of which the particles repel one another with a force inversely as the nth power of the distance, the viscosity is as the $(n+3)/(2n-2)$ power of the absolute temperature. Thus, if $n=5$, the viscosity is proportional to temperature.

Eiffel found that the resistance to a sphere moving through air changes its character somewhat suddenly at a certain velocity. The consideration of viscosity shows that the critical velocity is inversely proportional to the diameter of the sphere.

If viscosity may be neglected, the mass (M) of a drop of liquid, delivered slowly from a tube of diameter (a), depends further upon (T) the capillary tension, the density (σ), and the acceleration of gravity (g). If these data suffice, it follows from similarity that

$$M = \frac{Ta}{g} F\left(\frac{T}{g\sigma a^2}\right),$$

where F denotes an arbitrary function. Experiment shows that F varies but little and that within somewhat wide limits may be taken to be 3·8. Within these limits Tate's law that M varies as a holds good.

In the Æolian harp, if we may put out of account the compressibility and the viscosity of the air, the pitch (n) is a function of the velocity of the wind (v) and the diameter (d) of the wire. It then follows from similarity that the pitch is directly as v and inversely as d, as was found experimentally by Strouhal. If we include viscosity (ν), the form is

$$n = v/d.f(\nu/vd),$$

where f is arbitrary.

As a last example let us consider, somewhat in detail, Boussinesq's problem of the steady passage of heat from a good conductor immersed in a stream of fluid moving (at a distance from the solid) with velocity v. The fluid is treated as incompressible and for the present as inviscid, while the solid has always the same *shape* and presentation to the stream. In these circumstances the total heat (h) passing in unit time is a function of the linear dimension of the solid (a), the temperature-difference (θ), the stream-velocity (v), the capacity for heat of the fluid per unit volume (c), and the conductivity (κ). The density of the fluid clearly does not enter into the question. We have now to consider the "dimensions" of the various symbols.

Those of a are (Length)^1,
. . . . . . v . . (Length)^1 (Time)$^{-1}$,
. . . . . . θ . . (Temperature)^1,
. . . . . . c . . (Heat)^1 (Length)$^{-3}$ (Temp.)$^{-1}$,
. . . . . . κ . . (Heat)^1 (Length)$^{-1}$ (Temp.)$^{-1}$ (Time)$^{-1}$,
. . . . . . h . . (Heat)^1 (Time)$^{-1}$.

Hence if we assume

$$h = a^x \theta^y v^z c^u \kappa^v,$$

we have

by heat $1 = u + v$
by temperature $0 = y - u - v$,
by length $0 = x + z - 3u - v$,
by time $-1 = -z - v$;

so that

$$h = \kappa a\theta \left(\frac{avc}{\kappa}\right)^z.$$

Since z is undetermined, any number of terms of this form may be combined, and all that we can conclude is that

$$h = \kappa a\theta.F(avc/\kappa),$$

where F is an arbitrary function of the one variable avc/κ. An important particular case arises when the solid takes the form of a cylindrical wire of any section, the length of which is perpendicular to the stream. In strictness similarity requires that the length l be proportional to the linear dimension of the section b; but when l is relatively very great h must become proportional to l and a under the functional symbol may be replaced by b. Thus

$$h = \kappa l\theta.F(bvc/\kappa).$$

We see that in all cases h is proportional to θ, and that for a given fluid F is constant provided v be taken inversely as a or b.

In an important class of cases Boussinesq has shown that it is possible to go further and actually to determine the form of F. When the layer of fluid which receives heat during its passage is very thin, the flow of heat is practically in one dimension and the circumstances are the same as when the plane boundary of a uniform conductor is suddenly raised in temperature and so maintained. From these considerations it follows that F varies as $v^{\frac{1}{2}}$, so that in the case of the wire

$$h \propto l\theta.\sqrt{(bvc/\kappa)},$$

the remaining constant factor being dependent upon the shape and purely numerical. But this development scarcely belongs to my present subject.

It will be remarked that since viscosity is neglected, the fluid is regarded as flowing past the surface of the solid with finite velocity, a serious departure from what happens in practice. If we include viscosity in our discussion, the question is of course complicated, but perhaps not so much as might be expected. We have merely to include another factor, ν^w, where ν is the kinematic viscosity of dimensions (Length)^2 (Time)$^{-1}$, and we find by the same process as before

$$h = \kappa a\theta.\left(\frac{avc}{\kappa}\right)^z.\left(\frac{c\nu}{\kappa}\right)^w.$$

Here z and w are both undetermined, and the conclusion is that

$$h = \kappa a\theta.F\left\{\frac{avc}{\kappa}, \frac{c\nu}{\kappa}\right\},$$

where F is an arbitrary function of the *two* variables avc/κ and $c\nu/\kappa$. The latter of these, being the ratio of the two diffusivities (for momentum and for temperature), is of no dimensions; it appears to be constant for a given kind of gas, and to vary only moderately from one gas to another. If we may assume the accuracy and universality of this law, $c\nu/\kappa$ is a merely numerical constant, the same for all gases, and may be omitted, so that h reduces to the forms already given when viscosity is neglected altogether, F being again a function of a single variable, avc/κ or bvc/κ. In any case F is constant for a given fluid, provided v be taken inversely as a or b.

RAYLEIGH.

PERISCOPES.

WHILE the periscope of the submarine is developing in the direction of greater optical perfection and elaboration, there has been a return to the simplest and earliest types of periscope for use in land warfare. Some of these trench periscopes recall the polemoscope, described by Helvelius in the seventeenth century for military purposes; this polemoscope in its simplest form consisted of two mirrors with their reflecting surfaces parallel to each other, and inclined at 45° to the direction of the incident light. These mirrors were mounted in a tube and separated a convenient distance (Fig. 1).

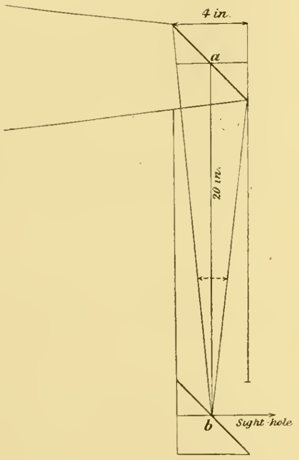


FIG. 1.

For modern trench warfare the convenient separation is about 18 to 24 in., and the mirrors are mounted in tubes, in boxes of square or oblong section, or attached to a long rod. In each case it is necessary that the mirrors should be fixed at the correct angle, and that there should be no doubling or distortion of the image.

The principal requirements of these trench periscopes are portability, lightness, small size and inconspicuous appearance, and large field of view. When there are no lenses the field of view is exactly the same as would be obtained by looking through a tube of the same length and diameter. Thus, with mirrors of 2 in. by 3 in. and a separation of about 22 in., a field of view of 5° would be obtained; and by moving the eye about, this field could be nearly doubled.

By using a box of oblong section the horizontal field of view can be increased without unduly increasing the size of the periscope. As the field of view is somewhat limited in any case, the principal objection to the use of a telescope or binocular, viz., the reduced field, no longer applies, and many periscopes are arranged to be used with a monocular or a binocular telescope.

Most periscopes can be used with a magnification of two or three, *i.e.*, with one tube of an ordinary opera glass; but when higher magnification is to be used the mirrors must be of better quality, both as regards flatness of surfaces and parallelism of the glass. When the mirrors are large enough—8 to 10 centimetres wide—both telescopes of the binocular may be used, but in this case the requirements for the mirrors are even more stringent, as the images formed by the two telescopes will not coincide unless the mirrors are plane. When suitable lenses are placed between the mirrors, the size of the mirrors can be reduced or the field of view increased; it is easy to provide a small magnification of the image or even to arrange for a variable magnification.

In such cases the lenses must be arranged to give an erect image, or mirrors or prisms employed to erect the image. An example of a periscope of this type is shown in Fig. 2, where the mirrors are replaced by reflecting prisms, and the prisms erect the image in much the same way as the prisms of a prism binocular.

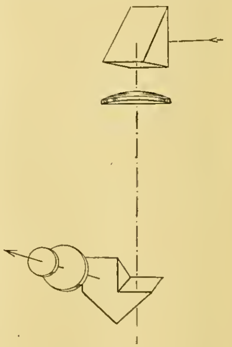


FIG. 2.

This arrangement is very suitable for a large magnification, but for larger fields the prism is unsuitable, unless it be silvered, and it is preferable to erect the image by means of lenses.

When longer tubes are used or larger fields are required, the design should approximate to that used in the submarine periscope.

This optical system has been steadily developed since its first introduction by Sir Howard Grubb in 1901.

The system consists of two telescopes, of which one is reversed, so that the image would be reduced in size, while the other magnifies this image, so that the final image is of the same size as the object, or is magnified one and a quarter or one and a half times. (As a very large angular field of view is required in these periscopes, the beam reflected into the tube must cover a large angle, and would soon fall on the sides of the tube; the reversed telescope, however, reduces the angle of the beam, and so enables it to proceed far enough down the tube to be received by the second telescope, and so transmitted to the eye.)

In modern submarines the tube has a length of from 16 to 24 ft., the diameter is from 6 to 9 in., while the field of view is about 65°. In order that objects shall look their real size, it is necessary to give a magnification of one and a quarter to one and a half.

Fig. 3 gives an illustration of a periscope in which three telescope systems are employed. The drawing is made from information published by Messrs. Goerz[1] of Berlin, and relates to periscopes made by them. It is, of course, undesirable to give any details of English periscopes at the present time.

An outer tube has a spherical glass cover. In the inner tube is the optical system, which can be rotated to face in any required direction; the eye piece, however, remains fixed.

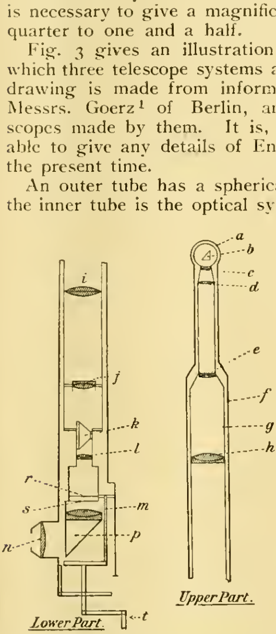


FIG. 3.—*a*, Glass cover; *b*, prism; *c*, *d*, and *e*, lenses of reversed telescope; *f*, outer tube; *g*, inner tube; *h*, *i*, and *j*, lenses of second telescope; *k*, reversing prism; *l*, *m*, and *n*, lenses of third telescope; *p*, prism; *r* and *s*, pointer and scale; *t*, rotating mechanism.

The optical system, which follows in its general principles Sir Howard Grubb's original design, consists of:—

(1) A reversed telescope, giving a reduction of about one quarter;

(2) A telescope, giving a magnification of about two;

(3) An erecting prism which can be rotated so that the image given by the system is correctly oriented;

(4) A telescope giving a magnification of about three.

This telescope includes a fixed eye piece and prism, so arranged that the observer looks horizontally at the object. At the focus of the eye piece are placed a scale and pointer to show the bearing of the object sighted, and a ruling to allow the distance to be estimated when the size of the object is known.

By the aid of a subsidiary system, special parts of the field can be further magnified to allow of objects being examined in more detail.

The continued use of the periscope is very trying to the eye, so that devices have been used to throw the image on to a ground glass screen. The ordinary eye piece and ground glass systems are made interchangeable, so that the observer can readily pass from one to the other; he may observe with the ground glass in the ordinary way, but examine special objects with the ordinary eye piece.

The field of view of the periscope is still limited, and various attempts to overcome this difficulty have been made. More than one periscope can be used and the images combined to form a complete image. A recent improvement consists in the use of a ring reflector which enables a view of the whole horizon to be obtained at once. The image formed by the ring system is much distorted, but when any object is picked up it can be examined by means of the ordinary system. These two optical systems are combined in one instrument, so that the two images are seen in the one field, the image formed by the ring system surrounding the other.

But these ring periscopes are still far from perfect, their distortion making it very difficult to identify objects; and this difficulty, though not so pronounced, occurs with the ordinary periscope. The point of view from which the surface of the sea and surrounding objects are seen is one to which the eye is not generally accustomed. The conditions of lighting, too, render it difficult to distinguish objects, especially when there is mist or spray, so that the effective use of a periscope requires considerable skill and training.

Trench periscopes may be obtained from most opticians, and the following are a few typical forms:—

The Hampson, wooden stake carrying two mirrors; price 7*s*. 6*d*.

The Adams, jointed rod; price 10*s*. 6*d*.

The Stanley; the support is in the form of lazy tongs, and is of a light alloy; price 25*s*.

These open-mirror types are light, portable, with good field, but the mirrors are not protected from rain, and the useful field is surrounded by bright sky.

Tube types are made by Messrs. Negretti and Zambra, Dixey, The Periscope Co., and many others; prices from 8*s*. 6*d*. to 15*s*., depending on the metal tube used. In these types the field is rather limited.

Messrs. Chas. Baker and Co. supply a type with large mirrors, which can be satisfactorily used with both barrels of a binocular. In spite of the large mirrors, the type is very portable; price 30*s*.

Many makers supply types in which the optical system is incorporated with the periscope, and the prices of these range from 28*s*. to 6*l*. 10*s*., according to the type of optical system used.

S. D. CHALMERS.

[1] Dr. Weichert, Jahrbuch der Schiffsbautechnischen Gesellschaft, 1914

OIL OF VITRIOL AS AN AGENT OF "CULTURE."

IN a former article under this heading (NATURE, December 31, 1914, vol. xciv., p. 472) we pointed out that Germany's ability to continue the war depended largely upon her power to maintain her supply of oil of vitriol, this product being absolutely indispensable in the manufacture of those high explosives upon which her artillery depends. We stated further that Germany's stock of the materials which are required to produce oil of vitriol is very limited, her sources of internal supply being almost negligible in comparison with the huge amounts demanded by her industries. An article by Dr. Reusch in a recent issue of the *Chemiker Zeitung* (vol. xxxviii., pp. 1241–43) is interesting at the present moment as showing that Germany is beginning to feel the pinch of necessity as regards this substance, and that, in view of the "reprisals" with which she is now threatened, as a consequence of her policy of "piracy and pillage," this necessity will become increasingly stringent.

We learn from Dr. Reusch's article that all export of sulphuric acid, sulphuric anhydride, and sulphurous acid from Germany is now prohibited. Before the war began she was a large importer of oil of vitriol—the imports in 1913 exceeding the exports by 65,289 metric tons—most of which came from Belgium. The total German production in 1912 is given as 1,649,681 metric tons, mostly made from pyrites, of which more than 80 per cent. was imported, mainly from Portugal, Spain, and France. Germany possesses deposits of this mineral, but they are of poor quality, and their working would present difficulties owing to scarcity of labour and other causes. She is now looking to Norway as a possible source, but if the policy indicated by Mr. Asquith is to be effective it should not be difficult to checkmate her action in this direction.

Another source of supply consisted in the working-up of zinc-blende, largely carried on in Silesia, principally on imported material, of which about 60 per cent. came from Australia alone. The only other main source would be natural sulphur imported through Italy, and principally of Sicilian origin, but here again, if the policy of "reprisals" is efficiently maintained, it should be readily possible for us to deal with this means of supply. It is interesting, in this connection, to note that in this respect, history repeats itself. During the Napoleonic wars the French occupied Sicily mainly with the view of cutting off our supply of sulphur for the manufacture of gunpowder in retaliation for our blockade of Pondicherry, upon which the enemy depended for his supply of nitre.

The sulphuric acid required for the manufacture of explosives is mainly employed in the production of nitric acid from nitrates, and from the point of view of hampering Germany in providing herself with the munitions of war it would be equally, if not more, effective to cut off her supplies of nitrates. As regards imported nitrates, and particularly Chile saltpetre, this may be practicable, and, indeed, cargoes of this material have already been stopped by our vessels on the high seas. But she has still certain internal sources of supply, as have most continental nations, and we now see that it is not for nothing that for some years past German chemists and engineers have, under the fostering influence of persons in high places, been straining every nerve to perfect possible synthetic processes of making ammonia and of converting it into nitric acid and nitrates, largely by the aid of the water-power of Norway.

Luckily for the Allies at the present juncture, certain of these processes, such as that of Ostwald, have turned out to be hopeless commercial failures, but there are others which would appear to have in them the promise of eventual and permanent success. We learn that the German Government has just introduced a Bill into the Reichstag providing for a State monopoly of the trade in nitrates for a period of seven years. The preamble explains that, at great expense, the Government has succeeded, in consequence of the stoppage of imports of Chile saltpetre, in establishing a chemical industry for the fixation of nitrates from the air, and that this industry is to be protected absolutely from all competition. Meanwhile, the price of nitrates, as of sulphuric acid, has steadily risen in Germany, and the shortage is becoming more and more pronounced. The process of depletion of sulphuric acid may be delayed by the action of the Government, which may be driven ultimately to commandeer all supplies in the interests of national defence. For the moment a certain amount is liberated in consequence of the diminished activity of various branches of chemical industry, as, for example, the dyestuff factories, and owing to the economy which has been enjoined in the manufacture of superphosphate manures, partly in consequence of the increased production of basic slag, due to the expansion of the iron industry. T.

PROF. H. W. LLOYD TANNER, F.R.S.

PROF. H. W. LLOYD TANNER, whose death on March 5 we announced with regret last week, was born at Burham, in Kent, on January 17, 1851. He received his school education at Bristol Grammar School, from which he proceeded to Jesus College, Oxford. At Oxford he came under the stimulating influence of Mr. John Griffiths, the mathematical tutor of his college. After leaving Oxford he held some educational appointments until the year 1883, when the University College of South Wales and Monmouthshire was founded at Cardiff. Of this college he was appointed Professor of Mathematics and Astronomy, and he occupied the chair at Cardiff until his resignation in 1909.

Cardiff University College now forms one of the constituent colleges of the University of Wales, but the Charter of the University was not granted until ten years after the opening of the college at Cardiff. In the interval the students of the college were prepared for the degrees of the University of London, and the courses of lectures in mathematics and other subjects were necessarily framed to meet the requirements of that University. After the foundation of the University of Wales the professors in the Welsh colleges enjoyed a degree of freedom in the choice and scope of the subjects they taught which had been denied to them when their students were reading for the degrees of an external university. Prof. Tanner took an active part in the arrangement of the mathematical work of the Welsh University in the early days, and the courses of study in pure mathematics still show the great influence he exerted on the general character of the mathematical teaching in Wales.

At Cardiff Prof. Tanner made a reputation for himself as an inspiring teacher and an excellent administrator. When the British Association visited Cardiff in 1891 he acted as one of the local secretaries, and the success of the meeting was in a large measure due to the thoroughness with which the secretaries carried out the necessary arrangements. After the death of Principal Jones he filled for some time the position of Acting-Principal of the college. In the year 1909 his health broke down, and he resigned his appointment as professor. In recognition of his services as head of the department of mathematics for twenty-six years, the Council of the college appointed him Emeritus Professor of Mathematics and Astronomy.

Amid all his varying activities in connection with his work in college, Prof. Tanner found time to engage in mathematical research, and he published in the Proceedings of the London Mathematical Society a series of valuable papers. His early papers, the first of which was written in 1875, dealt with the solution of partial differential equations, but his later papers were mostly concerned with the theory of numbers. These later papers were remarkable alike for grasp of principle, clearness of exposition, and elegance of method. The Royal Society recognised the value of his research work by electing him a Fellow of the Society in 1899. The University of Oxford also honoured him by conferring on him the degree of D.Sc., and by appointing him on one occasion an examiner for mathematical scholarships.

R. H. P.

NOTES.

The fifth annual May lecture of the Institute of Metals will be given on Wednesday, May 12, by Sir J. J. Thomson.

A special lecture on the septic infection of wounds will be delivered before the Royal Society of Medicine on Tuesday, March 30, by Sir Almroth Wright, who will deal with the results of his investigations and research with the Expeditionary Force.

A correspondent in Moscow informs us that the Imperial Society of Naturalists has removed the names of Prof. Haeckel and Prof. Ostwald from its list of members on account of their having signed the address, "To Civilised Nations," containing libels upon the Russian people.

The death is announced, at eighty-six years of age, of Dr. W. M. Dobie, who was associated with Charles Kingsley in founding the Chester Society of Natural Science, Literature, and Art, and was president of the society during the sessions 1893–94 and 1894–95.

The Board of Trade announces that in order to mitigate the effects of the dearth of indigo for dyeing purposes caused by the present war, and also to prevent any speculative holding up of natural indigo, the Government has acquired the greater part of the crop of natural indigo now coming forward for the use of dye-users in the United Kingdom.

The *British Medical Journal* has received a communication from a distinguished Scandinavian colleague in which he expresses the opinion that the reception accorded to foreign medical visitors in this country compares unfavourably with that they habitually receive from the medical profession in Austria and Germany. In these countries the practice of the large hospitals is placed at the disposal of foreign visitors without fee, whereas here fees more or less large are generally charged. This doubtless depends partly on the fact that our hospitals are voluntary and the staff is unpaid, whereas abroad the hospitals are Government institutions. The Germanic countries are also indefatigable in flooding the Scandinavian countries with their medical literature, while England and France, on the other hand, send scarcely a book for review to the Scandinavian countries. Here seems to be another opportunity for the extension of British enterprise.

Dr. Batschinski, of the University of Moscow, informs us that Prof. Nicolas Oumoff, whose death on January 15 was announced in these columns on January 28, was born at Simbirsk, East Russia in 1846. After passing through the University of Moscow he became lecturer and afterwards professor of theoretical physics at the University of Odessa. In 1903, after twenty-two years at Odessa, he was appointed professor of physics at the University of Moscow. Here, with the late Prof. Lebedew as his colleague, a large new physics institute was designed and erected. Prof. Oumoff was one of the Russian representatives at Lord Kelvin's jubilee, and received the honorary degree of LL.D. from the University of Glasgow. Along with many other Moscow professors, he resigned his position in 1911, and devoted himself to the Ledenzoff Society for assisting discoveries and inventions useful to humanity. He was very successful both as a university and as a popular lecturer. Of his published papers those on terrestrial magnetism are probably best known in this country.

The death is announced, at seventy-nine years of age, of Sir George Turner, whose researches relating to rinderpest, leprosy, and other diseases in South Africa are of high importance. Sir George Turner entered the Civil Service of Cape Colony as medical officer of health in 1895. The year after, rinderpest broke out in the Cape Colony. Koch had just devised a system of inoculation against this disease of cattle, and after three weeks' collaboration with him, Sir George continued the work, and before long devised a method of producing a lasting immunity by simultaneous inoculation with virus and serum. Within a year rinderpest in Cape Colony was stamped out; later, the same method was adopted in Egypt and Natal. In the South African war, on the outbreak of typhoid fever, he supervised the military hospitals and concentration camps. Afterwards he devoted his spare time to the leper asylum at Pretoria, and was assiduous in doing all he could to alleviate the lot of the inmates and in investigating the disease. On his retirement in 1907 he still continued his researches on leprosy in the laboratory, but after some years' work he noticed that he himself had contracted the disease which he had set himself to fight. Nevertheless, he still continued to work unswervingly amid the pain and beneath the shadow of a leper's lot.

THE arrangements which the Institute of Industry and Science (Aldwych Site, Strand, W.C.) has been making for some months past with regard to the holding of a conference in London of leaders of industry and science to discuss the British position, have now been completed, and a conference is to be held on Thursday, March 25, at the Mansion House. The proceedings will be opened with an address on the influence of science in political economy, to be followed by a discussion on the co-operation of science and industry. Many distinguished representatives of industry and science are expected to be present and to speak upon these and related subjects. A very effective organisation has already been created by the Institute of Industry and Science. At a meeting of the directors, held on March 10, it was resolved to place the organisation at the disposal of the Government without reservation, and this has already been done. A large number of the principal trade organisations are fully represented in the institute, and many eminent men of science and industry are taking an active part in its work. An important work, entitled "A Study of the First Principles of Production, and the Relation of Science to Industry," which has been in course of preparation for the last six months, by Mr. J. Taylor Peddie, will be published immediately by Messrs. Longmans, Green and Co., so as to be available before the conference. Attendance at the conference at the Mansion House is by invitation only.

IN the February number of the Journal of the Franklin Institute there is an interesting contribution by Dr. C. E. K. Mees under the title of "The Physics of the Photographic Process." He adopts Quincke's suggestion as to the sponge-like character of air-dried gelatine, with its cells and passages between them, and Joly's suggestion, which is confirmed by Nutting's calculation of the energy involved, that developable silver bromide is this salt which has lost one electron per grain (or particle). He thinks that reversal by the continued action of light is more likely due to the actual decomposition of the silver bromide, than to "self-neutralisation" brought about by the accumulation of the separated electrons in the gelatine surrounding the particles of silver bromide, as Joly and H. S. Allen have suggested, but we look in vain for any calculation as to whether the energy available is able to produce such a decomposition. He then considers the effects of the size of the grain, and states that a very fine-grained emulsion will never by cooking yield a very sensitive preparation. For this latter purpose one must *start* with a larger grain. In both cases sensitiveness increases as the grain grows. He considers, apparently favourably, the idea that greater sensitiveness is caused by the growth of the grain in size, and he illustrates by curves the effect of the gradation of grain size on the characteristic curve. An emulsion that is approximately homogeneous as to grain size gives a curve with a short "straight line" portion, while a larger proportion of smaller (less sensitive) grains, increases it, but a mixture of two emulsions, a low-speed fine-grained one with a high-speed, coarse-grained one, gives a very long under-exposure part to the curve. The author concludes with a short summary of recent work on the resolving power of plates.

PROF. J. STANLEY GARDINER, in lecturing on March 8 to the Royal Geographical Society on the geography of British fisheries, entered on a field which must have been as unfamiliar to most of his audience as it was interesting. After indicating the topography of the British fishing grounds, he illustrated the "correlation of habits with physical conditions" by discussing some of the remarkable facts in the growth, development, and movements of various food fishes which are gradually being brought to light. He mentioned the peculiar richness of the British fishing grounds as due largely to the quantity of organic remains derived from the land—indeed, he believed that drainage from the land would be found to be the "primary cause" of this richness, supplying the shallow seas with a substantial category of ingredients favourable to fish life. The varying character of the sea-floor, the movements of currents, and other phenomena were discussed as having important effects, some certain, some (so far as research has extended) no more than probable. Specially interesting was the reference to Dr. E. J. Allen's inquiry as to the relation between abundance of sunshine in early months of the year, the resultant rich cultures of diatoms, and the subsequent special abundance of copepods which feed on these, and of mackerel, which in spring feed largely on copepods. "We must regard as hopeful," he said, "the suggestion of physical data by which 'drifters' might be informed months beforehand of the probabilities of the fishery for the year."

PROF J. W. GREGORY, at a recent afternoon meeting of the Royal Geographical Society, discussed Suess's classification of Eurasian mountains. He contrasted it with other classifications, and commended it specially on the ground that "it separates the Himalayan line from the northern highlands, such as the Sayans, and from the north-eastern chains, such as the Yablonoi and Stanovoi mountains." Mountains widely different "in structure and geographical character," as these are, should be separated in classification, but Prof. Gregory stated that Suess did not always do this. He attached "excessive importance . . . to early earth movements which affected the foundations of the mountain areas," and his classification "does not serve ordinary geographical purposes, for it links together elements which are different in their topography and geographical influences, alike political, climatic, and biological; while it separates elements which have similar geographical influence." No doubt it was not primarily intended to serve these purposes, but Prof. Gregory adduced purely physical reasons—elevation at the same epoch, due to great crustal compression, etc.—for classifying together the Pyrenees, Alps, Dinaric mountains, the Caucasus, Himalaya, and others, whereas Suess's classification "represents the Alps as closer akin to the hills of Brittany than to the Himalaya, and makes the Dinaric mountains and the hills of Crete the European equivalents of the Himalaya," and "is obviously not intended as a guide to the comparison of existing earth forms."

AMONG many valuable contributions to our knowledge of the natural history of Gloucestershire contained in the Proceedings of the Cotteswold Naturalists' Field Club for 1914 is the account of an excursion to the Forest of Dean and a description of the work being done by the School of Forestry. Works have recently been erected containing a retort of large capacity for the carbonisation of wood, and the necessary plant for producing and working up charcoal, grey acetate of lime, miscible naphtha, and wood-tar. Mr. Hanson, a member of the school staff, among other interesting facts, remarked that after diligent search in the forest only fifteen mistletoe plants have been found, eight of which were on poplar trees and none on oak. This, he observed, tends to confirm the belief that the connection between the oak and the mistletoe in Druidic times is more mythical than real. He fails, however, to observe that it is the comparative scarcity of the appearance of mistletoe on the oak which would be likely to inspire a belief in its sanctity.

NEW material has enabled Mr. C. C. Mook (Ann. New York Ac. Sci., vol. xxiv., pp. 19–22) to formulate the distinctive features of Camarosaurus, described by Cope in 1877, and one of the first of the sauropod dinosaurs made known to science. It is now shown that Morosaurus, named by the same palæontologist about a month later, is really inseparable. It is also recalled that at first Cope believed these huge and unwieldy reptiles to be bipedal.

A LONG synopsis, illustrated by eight plates, of the British fleas, or Siphonaptera, by the Hon. N. C. Rothschild, renders the March number of the *Entomologist's Monthly Magazine,* about double the normal size, and the price is consequently raised in proportion to all save subscribers. It is the first attempt to bring a difficult subject up to date, and is consequently to some extent tentative. The descriptions are purposely brief, and the diagnoses of genera and species apply only to the British forms. The author remarks that in a considerable number of cases the same species of flea infests totally different kinds of animals, and that Carnivora frequently acquire such unwelcome guests from their prey, and may apparently retain them for a considerable time.

THOUGH the Scottish Zoological Park, near Edinburgh, has suffered from the effects of the war, it has been found possible to undertake during the winter several new works. The largest of these is the acclimatisation house, presented by Lord Salvesen, president of the society. Another is the construction of a pool for the society's valuable collection of penguins, which arrived from the Antarctic last spring. The pool is almost completed, and the penguins will be seen to much greater advantage than hitherto. The completion of the polar bear pool has also been undertaken. The formation of the polar bear pool was the first work undertaken by the society in the laying out of the park, but as it was not possible to have the pool, as originally designed, completed in time for the opening in 1913, a temporary barrier and cages were thrown across one side, so that the bears might be exhibited at once. The temporary wooden barrier has now been removed, and the rock on one side is being cut back, in order to enlarge the pool and at the same time afford a rock face of sufficient height to prevent the escape of the bears. The work on this pool will also be completed in a short time.

WE have been favoured with a copy of a richly illustrated memoir on the "Anthracolithic Faunæ of Kashmir, Kanaur, and Spiti," by Dr. C. Diener, published as vol. v., No. 2, of the new series of the "Palæontologica Indica." Fossils of a Permo-Carboniferous type were brought to light many years ago by Col. Godwin-Austen and others in Kashmir; and in the late 'seventies a fresh deposit of such fossils was discovered by Mr. Lydekker. The latter proved to be of the same type as those from the well-known Kuling shales of Spiti, and were therefore classed as Permian, while the great bulk of the fossiliferous deposits were originally regarded as Carboniferous; a third horizon, of presumed Carboniferous age, being indicated by a quartz-sandstone from Ladak containing a brachiopod first described by Dr. Diener as *Spirifer lydekkeri,* but now transferred to the genus Syringothyris. More important was the subsequent discovery by Dr. Noetling of plant-remains of a Gondwana type in the Kashmir beds. Dr. Diener's original memoir on the Anthracolithic series was published in 1899; the present one is based on new stratigraphical work and new collections, and contains descriptions of new species and revisions of others. As the results of his work, the author considers that the fossil evidence proves the Zewan beds of Kashmir to be the equivalent of the Upper Productus Limestone of the Punjab Salt Range and the Kuling Shales, this being confirmed by the presence in all of two distinctive Permian species.

DR. A. SMITH WOODWARD has written for the British Museum (Natural History) an inspiring illustrated "Guide to the Fossil Remains of Man in the Department of Geology and Palæontology," price 4*d*. Since the remains in other collections are here represented by casts, a comprehensive view can be obtained of the remarkable additions to our knowledge of human origins that have been made in the last eight years. One of the most interesting pictures is that showing the side aspect of the Piltdown skull, in comparison with that from La Chapelle-aux-Saints (Neandertal type) and with a modern human skull. Equally effective drawings are given of the skulls of chimpanzees, in young and adult stages. The possession of a complete skeleton of the Neandertal type has enabled M. Marcellin Boule to furnish a valuable comparison with that of the more erect modern Australian. The Piltdown type is regarded as even older than that represented by the mandible found at Mauer, near Heidelberg, in 1907. In stating that the immediate predecessor of modern man in Europe was of Neandertal type, Dr. Smith Woodward does not exclude the possibility of the contemporaneous existence of a type with less retreating forehead. The Transactions of the Perthshire Society of Natural Science (vol. vi., 1914) contain a paper by Dr. Lyell, in which the existence of man throughout the Glacial epoch is emphasised; and Mr. R. A. Smith's paper on prehistoric problems in geology, with the well-reported discussion on it (Proc. Geol. Assoc., vol. xxvi., 1915, p. 1) shows how far we have got from the old prejudices, which would have us believe that a deposit containing flint implements must necessarily be of post-Glacial age.

THE nature of "nardoo," the supposed nutritive food which led to such disastrous results during the ill-fated expedition of Burke and Wills, is discussed by Mr. E. H. Lees in the January issue of the *Victorian Naturalist*. It has been assumed that the true nardoo is made from the spores of a species of Marsilea growing in the swamps of Victoria. This, however, appears to be quite innutritious by itself, and nardoo made from leguminous seeds of various kinds is stated by the author to have been formerly supplied in establishments kept by natives. He maintains, in fact, that, in place of being the product of any one particular plant, nardoo is a compound made from several.

AN investigation into the limits within which the combined hysteresis and eddy current losses in iron per unit mass can be expressed by a single expression of the form, $W=cB^n$, has been carried out at Liverpool by Mr. N. W. McLachlan, who describes his results in a contribution to the Journal of the Institution of Electrical Engineers. Measurements were made by the Epstein alternating-current method with various brands of iron, and the curves obtained were analysed. It was finally found that such a formula would be accurate within from 1·5 to 2·5 per cent. for various materials tested, between the flux densities of 4000 or 5000 and 10,000 lines per sq. cm., and frequencies from 26 to 60 cycles per sec., the index n varying from 1·68 to 1·83, according to the material. Going closer into the matter, the constant c was found to vary directly with the frequency and the relation which exists between n and f was of the form $n=cf^{n_1}$.

THE results of a long series of researches on the conditions affecting the strength of wireless signals is published in a paper by Prof. E. W. Marchant, read before the Institution of Electrical Engineers recently. Daily observations, unhappily interrupted by the war, were made at Liverpool of the strength of signals sent out by the Eiffel Tower with a carefully calibrated apparatus and recorded by a suitable galvanometer. Attempts were made to draw general conclusions from the result, but in the opinion of several well-known wireless telegraph engineers who took part in the discussion, there was, in the absence of a control station near Paris, scarcely sufficient proof that the variations in received signal strength were due entirely to the degree of ionisation or other conditions in the intervening medium. Be this as it may, however, Prof. Marchant was able to show that the ratio between the day and night signal strength varies with the time of the year, and that the strengthening after sunset is less marked in rain than in clear weather, and is different in different directions. The greatest variations were observed at night. In his own opinion, moreover, the character and strength of the variations do point to the conclusion that the main factor which controls them is the state of ionisation of the atmosphere; he suggests that clouds of ionised air may exist in the upper regions of the atmosphere which act as mirrors for the waves and cause the sudden changes in signal strength that have been observed.

THE applications of electrical engineering to warfare formed the subject of an exceptionally interesting discussion at the Students' Section of the Institution of Electrical Engineers on March 3, under the chairmanship of Mr. W. Duddell. Mr. P. R. Coursey opened the discussion on "Communications," stating that the utilisation of the electrical telegraph for military purposes dated back only to the Boer war. In the Russo-Japanese war, field telegraphy and telephony, and also wireless telegraphy, were used; while in the present war not only do field telephones, and telegraphy with Morse sounders and "vibrator" instruments take an important part, but telegraphy is so much employed that transmission with Wheatstone automatic instruments actually finds useful application. Use is also made of wireless telegraphy. In the course of the discussion it was mentioned that, for wireless telegraph reception by airmen, pneumatic head-piece "shock-absorbers" are employed to deaden the noise of the engine. The subject of "The firing of mines and explosives" was opened by Mr. S. Killingback, who said that electric firing had the advantage over hand firing with time fuses, that it was more convenient and trustworthy, and also rendered possible remote control and the simultaneous firing of several charges. The standard electric fuses and detonators require about 0·8 ampere to actuate them, and are fixed either by accumulators or portable hand-operated service dynamos. One speaker in the discussion expressed the opinion that trinitrotoluene was superseding gun-cotton and gunpowder for the fuses, and another stated that electric firing had not been employed in the Russo-Japanese war, suggesting that its chief field in warfare was for the firing of mines for harbour protection for which more trustworthy and permanent cables could be laid. Mr. Duddell reminded the meeting of an exploder (of German make) captured from the Boers, which had been preserved in the Institution library.

THE harmful effects of aldehydes in soils are described by O. Schreiner and J. J. Skinner in Bulletin No. 108, Bureau of Soils, U.S. Department of Agriculture. In the course of examination of an acid garden soil for organic substances, salicylic aldehyde was isolated in amount sufficient to enable its effects to be tested on wheat plants grown in water culture. The harmful effect of the aldehyde, when added both to distilled water and to nutrient culture solutions, was so striking that an extensive series of experiments was undertaken in order to study the action of this compound on various plants and in various culture solutions, in soil in pots, and finally in the field. The plants used for the water culture experiments included wheat, maize, cow-peas, cabbage, and rice; for pot experiments trials were made with wheat, maize, and clover. In every case the depressing effect of the aldehyde was clearly shown. Thus in the case of wheat the addition of ten parts per million of salicylic aldehyde in distilled water reduced the growth by 31 per cent. compared with the control; with fifty parts per million the plants were killed. The experiments suggest that calcium carbonate and calcium phosphate restrain the toxic action of the aldehyde to a slight extent, but the cultures under alkaline conditions indicate that its harmfulness cannot be attributed to any slight acidity it may possess. Field trials made with cow-peas, beans, and garden-peas showed that these crops were all reduced when grown in soil treated with the aldehyde. Finally, seventy-four samples of soils, taken from various parts of the United States, were examined for aldehyde compounds; seventeen of these gave positive results. Ten per cent. of the soils known to be productive and 33 per cent. of unproductive soils contained aldehyde. The infertility of many of the soils is obviously due to causes other than the presence of toxic compounds, and especially of a particular toxic compound.

AN interesting letter from Prof. John Perry appears in *Engineering* for March 12. The subject dealt with is cheap and rapid gun-making, and Prof. Perry describes some experiments carried out under his instructions at Elswick, in which a cylinder of ordinary nickel steel, such as is used in guns, was constructed in such a manner that successive charges were exploded in it, finally reaching the high figure of 52 tons per square inch, without apparent damage to the cylinder. The cylinder was cast solid, or nearly solid, under pressure, and turned and bored not quite to the finished sizes. The ends were closed, and means adopted for filling it with fluid under pressure. The temperature was maintained by rings of gas jets outside (this prevents the yielding material from hardening too much). The internal pressure was raised rapidly to 17 tons per sq. in., and afterwards, during many hours, the pressure was increased gradually to 40 tons. It had been intended to increase the pressure until the outside diameter became permanently (and not merely elastically) larger. Prof. Perry gives a full account of the theory in his letter, together with tables of values of the internal stresses, from which the thickness of gun tubes can be calculated.

A PAPER was read by Sir Thomas Mason at the Institution of Civil Engineers on March 9, giving particulars of the improvement of the River Clyde and the harbour of Glasgow from 1873 to 1914. In 1873 the river from Glasgow to Port Glasgow had an average depth of 15 to 18 ft. below low water, and 25 to 28 ft. at high water. The largest vessels navigating the river had a draught of 22 ft. The total quayage of the harbour was 6410 yards in length, and the water-area was 76 acres. During the period considered, the Queen's Dock, Prince's Dock, Rothesay Dock, and several graving docks have been completed. Improvements on the river have had the effect of reducing the time of flow between Greenock and Glasgow; low water has fallen at Glasgow about 2 ft., and is now 5 in. lower than at Greenock. In 1873 springs rose 10 ft. 6 in.; now the rise is 12 ft. 2 in. The tonnage of trading vessels has increased by 325 per cent., length by 56 per cent., breadth by 69 per cent., and draught by 48 per cent. Quayage has increased three times; tonnage of goods handled four and a half times; and revenue nearly three and a half times. The water-area of harbour and docks is now 535 acres.

OUR ASTRONOMICAL COLUMN.

MELLISH'S COMET (1915*a*).—A recent number of the *Comptes rendus* (vol. clx., No. 9, p. 301) publishes observations of Mellish's comet made at the Observatories of Lyons and Marseilles. The observations at the former were made by M. J. Guillaume between February 20 and 26. The comet is described as of the eleventh magnitude, with the aspect of a circular nebula about a half-minute of arc in diameter, with vague boundaries, and with a condensation or very small nucleus excentric towards the sun. The note by M. Coggia on the observations at Marseilles describe the appearance of the comet as diffuse, irregular, without any brilliant part or condensation. Its magnitude is given as 11. The ephemeris given in this column last week extends up to March 24.

SUN-SPOT AND MAGNETIC ACTIVITY IN 1913.—Prof. A. Wolfer brings together in the *Astronomische Mitteilungen* (No. 105, p. 115) the very valuable statistics of the solar and magnetic acitivity for the year 1913. The statement is based on the large number of observations made at numerous observatories, and affords a ready means of comparing the relative changes which occur from one year to another. The year 1913 seems to have been a very quiescent one according to the value arrived at for the spot activity, and the diminution in activity from the year 1911 will be seen from the following figures:—

1911, 5·7; 1912, 3·6; 1913, 1·4.

This quiet state of spot activity is in close accord with the condition as deduced from the discussion of the mean areas and heliographic latitudes of sun-spots in the year 1913 at the Royal Observatory, Greenwich (*Monthly Notices*, R.A.S., vol. lxxv., No. 1, p. 16).

The value for the daily variation of magnetic declination, on the other hand, has shown a pronounced indication of activity for the year 1913, showing that the minimum took place in 1912, a year earlier than that of the sun-spot.

REPORT OF MOUNT WILSON SOLAR OBSERVATORY.—The annual report of the Mount Wilson Solar Observatory gives the reader a good insight into the remarkable activity that has been, and is, in progress. Before proceeding to give somewhat in detail an account of the work in the various departments, the director, Prof. G. E. Hale, enumerates in the fifty-nine brief paragraphs the principal conclusions to which the work of the past year have led. These are, of course, too numerous to give here, but many of the conclusions have been referred to in previous accounts of research work in this column. This report completes the first decade of operations on the mountain, and we are promised a brief outline of the work for this period. The past year is described as "one of the most productive of this period." We are told that solar research has progressed satisfactorily, that a beginning has been made in the application to solar phenomena of Stark's capital discovery of the effect of an electric field on radiation. One of the new conclusions in stellar astronomy promises to furnish the means of determining a star's distance simply by measuring its brightness and the relative intensities of certain lines in its spectrum. Laboratory investigations and the work of construction have gone forward rapidly. With regard to the last-mentioned, it is hoped to complete the dome for the 100-in. reflecting telescope next summer, and to set up the mounting in the autumn. The large mirror has already received an almost perfectly spherical figure, and preparations are being made for the work of parabolising it. The reader must refer to the report itself to note the progress made in the many and various investigations which are in operation, both on the mountain and at the base station.

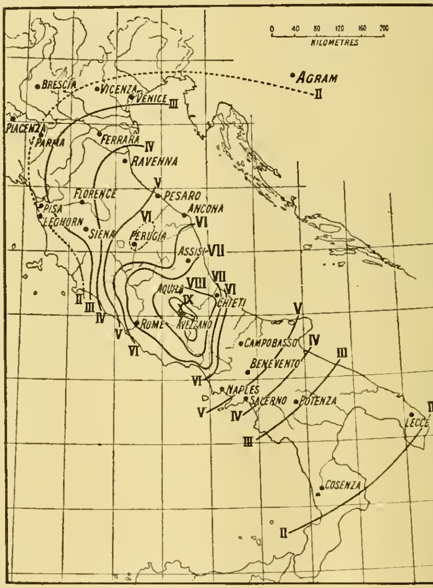
ANNUAIRE ASTRONOMIQUE ET MÉTÉOROLOGIQUE POUR 1915.—The fifty-first issue of the useful handbook entitled "Annuaire Astronomique et Météorologique" has just come to hand. M. Camille Flammarion, the originator and editor of this handy reference book, has, in spite of the recent difficulties met with in Paris, produced the volume up to the high standard of its predecessors. Most of the readers of this column know the arrangement and subjects of the contents so well that it seems necessary only to direct attention to the issue of the volume. Nevertheless it may be added that under the heading, "Scientific Notices," which is an annual review of the progress of astronomy, the reader will obtain a good broad view of the year's work, while in the numerous other sections dealing with the calendar, phenomena, astronomical tables, etc., illustrated by 120 figures of charts and diagrams, a mine of valuable material is included.

THE AVEZZANO EARTHQUAKE OF JANUARY 13.

FOR most of the details contained in the present paper I am indebted to the courtesy of Dr. G. Martinelli, of the Ufficio Centrale di Meteorologia e di Geodinamico at Rome, and of Dr. G. Agamennone, the well-known director of the Geodynamic Observatory of Rocca di Papa, near Rome.

The map of the isoseismal lines is a reproduction of that prepared by Dr. G. Martinelli from the numerous observations forwarded to the Central Office. The scale of intensity employed is that of the late Prof. Mercalli, which, in Italy, has superseded the Rossi-Forel scale. The degree X., for instance, represents the intensity of a shock capable of ruining many buildings and causing much loss of life; the degree VII. that of a shock that will throw down chimneys and produce slight cracks in numerous buildings; while the degree II. corresponds to a shock that can just be felt under favourable conditions by persons at rest. It will be seen that the isoseismal X. is an elongated curve including Avezzano at its western end. The isoseismal of intensity VII. is interrupted by the eastern coast of Italy, and extends beyond Rome to within a few miles of the western coast. The isoseismal of intensity II., which represents the boundary of the disturbed area, includes Parma, Mantua, Verona, and Venice to the north, and to the south approaches within thirty miles of Messina. Thus the area disturbed is not less than 550 miles in length. Its width is, of course, unknown, but, if the mean radius be taken as 275 miles, the total disturbed area must extend over about 240,000 square miles, an area about two-thirds of that shaken by the San Francisco earthquake of 1906.

Dr. Agamennone informs me that the first vibrations were registered at the Rocca di Papa Observatory at 6h. 52m. 54s. a.m. (G.M.T.), but the vibrations soon attained such strength that the seismographs there were thrown out of action. At Rome, a somewhat less sensitive seismograph registered the whole movement, though the pendular masses beat repeatedly against the screws which are arranged to protect the instrument from excessive oscillation. At Eskdalemuir, the first movement was recorded by the Galitzin seismograph at 6h. 56m. 45s., and the beginning of the principal portion at 7h. 1m., the instrument remaining in motion until 9h. 12m. Judging



from the seismogram obtained at this observatory, the epicentre was at the distance of 1930 km. in the direction 40° 50′ south of east; that is, in 42° N. lat., 14° E. long. The centre of the isoseismal line of intensity X. is in 42° 0′ N. lat., 13° 27′ E. long. According to a special seismological bulletin issued by the Georgetown (U.S.A.) University Department of Geology, the first tremors reached that place at 7h. 28m. 40s., and the first oscillations of the principal portion at 7h. 36m. 40s.

The Avezzano earthquake is noticeable for its extraordinary number of after-shocks. At Rocca di Papa, a sensitive microseismograph was at work again an hour after the principal shock, and, from January 13–29, this instrument registered more than 500 after-shocks. That the earthquake was tectonic in its nature is indicated by the extensive disturbed area, the registration of the movement at great distances, and the unusual frequency of the after-shocks.

The earthquake is being investigated by Dr. Mario Baratta on behalf of the Italian Geographical Society. A preliminary notice by Dr. G. Martinelli will appear in the next number of the *Bollettino* of the Italian Seismological Society, and will include the map of the isoseismal lines reproduced here, and also a map prepared by Dr. Baratta to illustrate the seismic history of the district. From the latter, it is evident that the epicentral area of the recent earthquake, though not far distant from the important seismic zone of Aquila, is one in which only earthquakes of slight intensity have originated in the past.

(Since the above was written, a short paper on the earthquake by Dr. G. Agamennone has appeared in the *Rendiconti* of the R. Accad. dei Lincei (vol. xxiv., 1915, pp. 239-46). The author states that the most sensitive microseismometrograph at Rocca di Papa (about forty-three miles from the epicentre) recorded 240 after-shocks from 8.37 a.m. to midnight (that is, from 7.37 a.m. to 11 p.m., G.M.T.) on January 13, and on each of the four succeeding days 120, 88, 38, and 30, the total number of after-shocks until February 6 being nearly 750, of which only about thirty were felt at the observatory or in the surrounding country.) CHARLES DAVISON.

SANITATION IN INDIA.[1]

WE have before us four volumes of papers presented to the All-India Sanitary Conference held at Lucknow in January of last year. Vol. ii. commences with an interesting account of the methods by which in Italy the silt of rivers is utilised for raising the level of the soil, while at the same time the level of the water is lowered by drainage. The system can be carried out with the primary object in view of reclaiming swampy land or the agricultural improvement can also be considered, an almost necessary procedure from the financial side. How far the method is applicable to India is a matter of great interest. One factor that has to be determined is the amount of silt in the particular river under consideration, and, secondly, if agricultural improvement is to be considered, whether the silt is of manurial value. The views of the agriculturist, the engineer, and the sanitarian all need consideration in a problem of this magnitude. How manifold and fundamental the problems are, a consideration of the papers dealing with malaria will show. It is indeed no little achievement that this immense malaria problem is now being studied in India in all its aspects, and that its solution has already progressed far from the facile position held not so long ago by many that the filling up of a few pools and ditches was the answer.

An anti-fly campaign was carried out in Delhi with considerable success, the methods employed being:—(1) Either the burning of rubbish or covering it with one foot of earth; (2) the trenches of trenching grounds were cut $1\frac{1}{2}$ ft. deep and covered with a foot of earth well-rammed down; (3) the use of incineration at the latrines; (4) the cleaning and sprinkling with pesterine of stables, cowsheds, backyards, etc.; (5) litter was removed daily or burned, bedding was changed at least once a week; (6) garden manure was not allowed to be exposed for more than four days—after this it must be dug into the ground and covered with a foot of earth; (7) butchers' shops and vegetable shops were dealt with; and (8) in private latrines, pucca floors and drains were made compulsory. The result of this campaign was that flies were "enormously reduced" and apparently the infantile mortality statistics. It was not, however, until the breeding-grounds within the city—*i.e.* those comprised under headings (4) to (8)—were dealt with that progress was made.

In England the essential points in the bionomics of the fly have been known for some years, but flies still infest our large towns. Is it the inadequacy of the powers possessed by the sanitary authorities that allows this insane condition to continue, or is it the apathy that allows us also almost without a murmur to permit foul smoke to be discharged from our chimneys?

The section on conservancy contains two interesting notes on the "pitting" of night soil, a simple and effective method of solving under certain conditions this ever-recurring problem. The essence of the method consists in sealing the pits from access of flies, etc., with road sweepings.

In vol. iii., the problems of tuberculosis and the very difficult one of a pure milk supply, water supply, notification of disease, and various questions in connection with sewage disposal, are discussed in several papers. An important one is the disposal of sewage sludge; the Grossman process in use in Oldham, where the sludge is dried and freed of its fat by passing steam through, yielding a valuable manure, seems successfully to solve the problem under certain conditions.

Vol. iv. The regulations for the control of malaria in Portuguese India are somewhat rigorous, *e.g.* all vessels intended to hold water will be closed and their contents changed *at least every two days.* Once a week at most is sufficient, as mosquitoes cannot develop from eggs in two days. Again, not only are ventilation outlets of drains to be furnished with wire gauze, but oil is to be poured into the openings to make assurance doubly sure, we suppose. A method for destroying larvæ that we do not remember to have seen mentioned before is contained in the following regulation. "Herds of animals will be introduced periodically (into ponds) to stir up the water, thus making it unsuitable for anopheline larvæ"!

In another paper figures are given which suggest that one species of malaria parasite prevails at one season of the year, another at another. If this is really so, and apparently similar results have been observed elsewhere, it would be important to know the reason for this.

A very interesting paper is that dealing with certain features of malaria in the island of Salsette. One main fact comes out, viz., that malaria increases as one approaches the hills. The study of the conditions in an island have always appeared to us especially interesting, and it is to be hoped that it can be repeated year after year. It shows clearly the great importance of an extended malaria survey of a district before houses are built anywhere and everywhere without consulting expert sanitary opinion.

Another interesting point is the effect of sea breezes in reducing the endemic index of malaria; "villages exposed to the sea-breezes have no spleen rate at all." Emphasis is also laid on that ubiquitous evil, the "borrow" pits along the railway track. Under existing conditions the only practical policy recommended is the abolition of these pits, the exposure of villages to sea breezes by the cutting down of grass and undergrowth, the institution of travelling dispensaries, and the proper control of new building schemes. A general attack on breeding-grounds in rural districts seems impossible. Certain areas of the island are free from malaria, and development should be recommended in these. The question of rice fields and malaria is one of first-rate importance. It would appear that we can get in a rice cultivation area three conditions:—(1) Healthy: spleen rate, 4·3 per cent.; (2) malaria endemic: 24·1 per cent.; (3) malaria hyperendemic:

[1] Supplement to the Indian Journal of Medical Research. Proceedings of the Third All-India Sanitary Conference held at Lucknow, January 19-27, 1914. Vol. ii., Papers, pp. ii+186. Vol. iii., Papers, pp. iv+220. Vol. iv., Papers, pp. iv+212. Vol. v., Papers, pp. iv+226. (Calcutta: Thacker, Spink and Co., 1914.)

70·5 per cent. The healthy areas are in the open plains, the hyperendemic areas at the foot of the mountains, where shade produced by forest, jungle, long grass, scrub, etc., exists, and (3) the endemic area with intermediate conditions. These data illustrate also the great value of malaria surveys before recommendations based simply on general principles are carried out.

Guinea-worm prevails to the extent of as much as 4 per cent. in some of the Indian jails. In a certain Bombay village over a third of the Cyclops in the village well contained larvæ, but the villagers put all the usual obstacles in the way of improving the well and their health.

Vol. v. contains an extremely interesting method of classification of Anophelines based on the distribution of "spots" on the wings; three main groups, Protoanopheles, Deuteroanopheles, and Neoanopheles, are easily separated.

The problem of the mode of dissemination of kala-azar is still *sub judice*; the balance of opinion favours the bed-bug as the agent. It has occurred to the writer as a not impossible hypothesis that perhaps this and some other diseases are not insect-man-insect diseases, but insect-man diseases only, *i.e.* the infecting agent is inoculated into man from and by an insect, produces its ill-effects, but is not further transmissible.

As regards the destruction of rats in plague prophylaxis, we have the merits of two methods put forward, viz.: (1) phosphorus, made up in attractive balls containing less than 3 per cent., and (2) hydrocyanic acid gas. This last kills not only rats but fleas, and its only drawback appears to be its very poisonous character. Its detection, however, is an easy matter, viz., by means of a paste which forms with it prussian-blue. The amount requisite is $\frac{1}{2}$–$\frac{3}{4}$ of an ounce of potassium cyanide per 100 cu. ft. It has many advantages over the sulphur dioxide or carbon monoxide methods.

There are many other subjects, such as vital statistics, water filtration, that we have not alluded to, but one would refer those who wish to obtain a general idea of the scope of these important conferences to the summary contained in the *first* volume. We ought to end with a word of congratulation on the splendid work that is being done.

J. W. W. S.

ORNITHOLOGICAL NOTES.

IN the February number of *British Birds* Miss M. D. Haviland continues her account of ornithological observations made in the delta of the Yenisei, dealing in this instance with the little stint. So fearless during the nesting season were these birds that it was with difficulty they were kept far enough away from the camera to admit of the taking of a satisfactory photograph; and a brooding cock captured by the author in her hands, when released returned to the young. In six out of eight instances the sitting birds were cocks, but whether both sexes take their share in incubation was not ascertained.

The distribution of birds in Ceylon, in relation to recent geological changes in that island, forms the subject of an article by Mr. W. E. Wait in *Spolia Zeylanica* for December, 1914. (vol. x., part 36). A large proportion of the resident birds, especially in the Kandyan provinces and the wet zone of the low country, are of a Malabar type; but in the north and north-west there is a nearer affinity with those of the Carnatic. Of the peculiar species, the greater number pertain to the Malabar type of the fauna, and have their headquarters in the wet zone, but there are also a few with a Himalayan or Malay *facies*, although none of the Carnatic types. As the theories advanced by the author to explain these peculiarities in distribution are confessedly tentative, quotation seems unnecessary.

In the *Zoologist* for February Miss W. Austen records the appearance of a flock of about thirty long-tailed tits in a garden at Maida Hill on October 1, 1914, an occurrence which the editor believes to be altogether unprecedented.

To the January number of the *Auk*, and likewise to *Blue-Bird* for the same month, Dr. R. W. Shufeldt contributes a note on the last survivor of the American passenger-pigeon, which died in the Cincinnati Zoological Gardens on September 1, 1914, at the age of twenty-nine years. Immediately after death the body, packed in ice, was forwarded to the National Museum at Washington, where the skin was carefully removed for preservation, doubtless in the study series. Before this took place a photograph of the head and neck was taken and coloured with Japanese tints from the specimen; this photograph, after the insertion of an artificial eye, being reproduced in colour in the aforesaid issue of *Blue-Bird*.

R. L.

NOTES ON GLASS.[1]

A CERTAIN amount of experimental work on glass-ware of various kinds has been carried out recently at the National Physical Laboratory, and it may be of interest to make known some of the results.

Chemical investigations have for some years been dependent on German glass; the publication of the analyses and of test results may, it is hoped, lead some English firms to produce articles which may replace those of German manufacture.

The first table gives the analyses of some thermometric and chemical glass-ware.

Analyses of Thermometer and Chemical Glass-ware.

	Thermometer Glasses		Schott and Gen., Jena		Chemical Glassware		
	Jena 59III	Jena 16III	Original	"New"	Resistance "R"	Kavalier's Bohemian	Thüringen
Silica	72·86	66·58	66·74	64·60	68·00	76·02	74·36
Alumina	6·24	3·84	2·77	6·24	2·32	0·64	0·90
Lime...	0·35	7·18	0·28	tr.	4·80	7·38	9·40
Zinc oxide ...	—	6·24	8·28	10·43	2·40	—	—
Manganese oxide	tr.	0·28	0·65	tr.	0·14	tr.	tr.
Ferric oxide ...	tr.	tr.	tr.	tr.	tr.	tr.	tr.
Lead oxide ...	—	—	—	—	—	—	—
Soda (Na_2O) ...	9·82	14 80	8·99	9·71	10·17	7·60	14·83
Potash (K_2O) ...	0·10	tr.	0 08	tr.	1·82	7·70	0·14
Boric anhydride.	10·43	0·91	7·18	8·70	5·53	—	—
Magnesia	0·20	0·17	4·50	0·32	5·04	0·30	0·16
Arsenious oxide.	—	—			0·24		
	100·00	100·00	99·47	100·00	100·46	99·64	99·79
	*	*		*			

Analyses made with an asterisk have been made at the N.P.L. The other analyses are taken from a paper by Walker in the Journal Am. Chem. Soc., xxvii., 865, 1905.

(Bohemian and Thüringen glass is now rarely used in chemical work, but the analyses given are of the best material of that class.)

Resistance of Various Chemical Glass-ware to the Action of Chemical Attack.

The table below, taken from the work of Mylius and Foerster on this subject, gives the action of

[1] From the National Physical Laboratory, February, 1915.

various chemical reagents on glass used for chemical purposes (for analyses, see foregoing table):—

Beakers.

Type of Glass.	Water. 20°	Water. 80°	H_2SO_4	NaOH	Na_2CO_3
"R" ...	0·0054	0·0144	0	41	23
Jena ...	0·0071	0·0035	0	53	19
Bohemian	0·118	0·219	5	37	49

Flasks.

Type of Glass.	Water. 20°	Water. 80°	H_2SO_4	NaOH	Na_2CO_3
"R" ...	0·0128	0·0128	0	51	26
Jena ...	0·0063	0·0057	0	63	24
Bohemian	0·093	0·255	11	52	70

The figures are in milligrams per sq. dcm.

The solutions, viz. 2N.NaOH and $N.H_2SO_4$ were allowed to act at 100° for six hours, and $2N.Na_2CO_3$ for three hours.

The Jena glass used was probably of the composition given in the first foregoing table under description "Original." This glass is now not used, but has been replaced by the new Jena glass, an analysis of which has been made at the National Physical Laboratory. Soon after the introduction of this new Jena glass by Schott and Gen., viz., in 1910, some tests were made at the National Physical Laboratory. A special feature of the new glass was its increased resistance to attack; this was brought about by long exposure to sulphureous gases. The tests on the glass before and after such treatment are given in the table below. Several kinds of vessels were tested, and the results for all were substantially the same.

Tests made at the N.P.L. in 1910 on "New" Jena Glass.

Mark: (1) Vessels had received no annealing.
(2) Vessels had received ordinary annealing.
(3) Vessels had received special annealing in sulphureous gases for thirty-six hours.

Beakers.	Milligms. Na_2O per sq. dcm. given up to water at 20° C. in 1 week.	Milligms. Na_2O per sq. dcm. given up to water at 80° C. in 3 hours.
1 ...	0·0022 ...	0·0045
2 ...	0·0032 ...	0·0047
3 ...	0·0019 ...	0·0040

In the following table the figures give the loss in weight in milligms. per sq. dcm. after the treatment stated.

Beakers.	3 hours with 2N NaOH at 100° C.	3 hours with 2N Na_2CO_3 at 100° C.	6 hours with N H_2SO_4 at 100° C.
1 ...	51 ...	9 ...	nil.
2 ...	51 ...	8 ...	nil.
3 ...	55 ...	7 ...	nil.
Conical Flasks			
1 ...	63 ...	8 ...	nil.
2 ...	60 ...	11 ...	nil.
3 ...	71 ...	10 ...	nil.
Flat-bottomed Flasks			
1 ...	62 ...	8 ...	nil.
2 ...	71 ...	8 ...	nil.
3 ...	79 ...	6 ...	nil.

There was a small improvement as regards resistance to the attack of water, but no improvement to the attack of alkalies. Since its introduction this type of glass-ware has been used in the National Physical Laboratory and has given every satisfaction.

It is well known that alkaline fluids attack glass very markedly, and for that reason in chemical analyses prolonged contact is avoided. To do this is not always possible, *e.g.* in the estimation of zinc and manganese, especially in silicate analyses. It is necessary in the estimation of these metals to employ solutions containing alkaline chlorides and ammonium sulphide, and to allow the solutions to stand at a rather high temperature (50–60° C.) for sometimes as long as twelve hours. In these circumstances the glass is invariably attacked, and although no quantitative experiments have been made with the Jena glass, the resistance to the attack of these solutions is certainly not as good as with the alkaline solutions in the absence of chlorides and sulphides. In view of the fact that glass flasks have to be used for this purpose, it seems desirable to devise a test, in addition to the tests usually carried out, to determine the ability to withstand the joint action of alkaline chlorides and sulphides.

The new Jena glass examined at the National Physical Laboratory in 1910 possessed in a very high degree the ability to withstand sudden change of temperature. A glass flask filled with molten paraffin wax at a temperature of 250° C. broke when placed suddenly in water at 15° C., but only after successfully standing such a test at slightly lower temperatures.

Another question which is engaging attention is glass for miners' lamps, incandescent chimneys, steam gauge tubes, and other purposes in which a gradient of temperature is established between the inside and outside.

Analyses of some of these glasses are given in the following table:—

Analyses of Lamp Glasses.

	Jena Incandescent Gas (Schott & Gen.) Best Quality.	Miner's Lamp Glass. German Make. Mark A [1] B.	Miners' French Lamp Glass (Yellow).	Miners' French Lamp Glass (Colourless).	Austrian Lamp Glass "Sun Brand."
Silica	73·88	74·28	51·26	54·92	76·78
Alumina	2·24	3·24	6·90	1·28	0·72
Lime	tr.	tr.	tr.	tr.	6·52
Zinc oxide ...	tr.	tr.	7·16	0·82	—
Manganese oxide	tr.	tr.	tr.	tr.	tr.
Ferric oxide ...	tr.	tr.	tr.	tr.	tr.
Lead oxide ...	—	—	27·54	34·93	—
Soda (Na_2O) ...	6·67	6·73	tr.	2·08	11·14
Potash (K_2O) ...	tr.	tr.	2·67	4·54	4·74
Boric anhydride.	16·48	15·02	3·97	—	—
Magnesia	tr.	tr.	tr.	0·20	0·24
Arsenious oxide.	0·73	0·73	—	0·99	—
Antimony oxide.	—	—	0·50	—	—
	100·00	100·00	100·00	99·76	100·14

It appeared, however, from Hovestadt's book on glass, and other information, that the additional strength of the German glass was conferred on it in great measure by its heat treatment, and tests were made to investigate the state of strain in the glass.

For this purpose the following glasses were examined:—

(1) A miner's lamp chimney of white glass of German manufacture.

(2) A miner's lamp chimney of yellow glass of French manufacture.

(3) A piece of "Durax" tubing as used for chemical purposes.

From each of these tubes two rings of about 1 cm. depth were prepared by making transverse cuts across the tubes; the plane surfaces of the rings were optically polished. One ring of each specimen had a piece cut out so that the ring was free to spring. Other pieces were prepared for the determination of the refractive properties of the glasses.

The three open and three complete rings were examined in plane polarised light for strain. The examination showed that in both rings of the French glass, and in the open ring from the German lamp chimney, the amount of strain was negligible. In the unbroken ring from the German chimney there was very decided strain. Strain was also present in both rings of the "Durax" glass, the unbroken ring of this material showing much more pronounced strain than any of the other rings. The appearance presented by the rings when examined in the dark field is a very strong and sharp black circular line in the middle of the glass with a decided black cross upon it, and the rest of the ring either white or milky.

The character of the strain present in the unbroken ring from the German chimney was determined by distorting the ring into an elliptical form by compression between two points at opposite ends of a diameter of the ring inclined at 45° to the plane of polarisation. By this means the milkiness could be made to disappear entirely from the regions about the diametrical plane perpendicular to the line of compression, but the strain in the neighbourhood of the points of compression was increased. This shows that the strain is relieved by an increase in the curvature, and augmented by a reduction in the curvature; in other words, the inner layers of the ring are in a state of tension, and the outer layers in a state of compression. The fact that in the open ring the strain throughout is practically entirely relieved suggests that these chimneys are made in one operation, and not by the combination of layers of material at different temperatures. It is evident that with the distribution of strain in the cold state indicated above, the chimney will tend to be relieved of strain when there is a radial temperature gradient throughout its substance with the outer surface cooler than the inner surface.

With the "Durax" tubing there is in neither ring freedom from strain. In the open ring the strain becomes worse on altering the curvature in either direction. Perhaps this indicates that the tube is built up of layers of the same or different materials, but brought together with one layer decidedly cooler than another. The presence of a thin white band in the substance of the glass may also indicate that the tube has been built up in the way suggested. An examination of all the rings in ordinary light showed the presence of striæ likely to prevent the formation of really sharp spectrum lines in the determination of their refractive properties. This expectation was fully borne out by the appearance of the lines in the refractometer. No indication was obtained that any tube consisted of more than one type of glass, but the want of sharpness in the lines was sufficient to obscure the difference between glasses of very nearly identical optical properties. The results obtained in these measurements are as follows:—

	n_D	$n_C - n_F$	ν
German chimney ...	1·4795	0·00729	65·8
French chimney ...	1·5748	0·01313	43·8
"Durax" combustion tubing	1·5156	—	—

The *optical* glasses which resemble the above in refractive properties are, for the German chimney one of the new "Fluor Crowns," for the French chimney a light flint, and for the "Durax" tubing a hard crown.

Experiments were made to determine possible variations in the strained condition of lamp chimneys due to internal heating and resulting temperature gradient across the glass.

Coils of wire were wound round a cylindrical metal core, the whole enclosed in asbestos paper and fitted closely (without mechanical strain) into the ring of the chimney examined. A thermo-couple was introduced between the lagging and the glass to enable the temperature of the latter to be determined on the passage of a current through the heating coil.

French Chimney.—This was initially when cool without strain. On heating up strain was found to develop progressively as the temperature rose, and there is no evidence that at any temperature the strain declines to a minimum again.

German Chimney.—When cool and at uniform temperature this showed very decided strain in the shape of a central ring and cross. On heating up the ring the strain was relieved, but the glass is never *entirely* freed from the strain as evidenced by a complete absence of the stauroscopic figure. The tendency is rather for the central dark ring to move outwards and to be replaced eventually by another ring moving out from the inner surface of the glass ring. There is nevertheless a decided minimum effect, *i.e.* minimum strain, obtained when the temperature of the inner surface of the glass ring is about 150° C. (±20°). The temperature gradient across the glass is such that in the steady state the temperature of the outer surface of the lamp, corresponding with the above internal temperature, is roughly 70°, within the same limits of accuracy. Excessive heating above these limits results merely in producing a more pronounced strain.

A further chemical analysis of the inner layers confirmed the view that the German miner's lamp chimney is of a single material.

The incandescent lamp chimneys are very thin and optical examination is not possible, but it appears fairly certain that in their case also the extra strength is attained by some process whereby the outside is chilled before the interior cools down. It seems possible also that the extra heat-resisting qualities of certain beakers, flasks, etc., of German glass may be due to the converse process, the interior being chilled previously to the exterior. All these glasses appear to be of the borosilicate type, such as is used for the well-known thermometer glass 59^{III}, but with somewhat more boric anhydride; the chemical glass contains zinc oxide, which is absent from the thermometer glass.

As already stated, the object of these notes is to put such information as is available before English manufacturers in the hopes of encouraging some of them to take up the manufacture of some of these glasses.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. TRAVERS SMITH has been appointed to the chair of materia medica, therapeutics, and pharmacology in the school of surgery of the Royal College of Surgeons in Ireland.

THE will of the late Mr. W. E. Allen, chairman of Messrs. Edgar Allen and Co., Ltd., of the Imperial Steel Works, Sheffield, who died in Jnuary last, provides that two-fifths of the residue of his property after the payment of numerous bequests to charities and employees, shall be given to the University of Sheffield, to be applied as to 5000*l.* to the Applied Science Department, and as to the balance, in the discretion of the University Council, in founding Edgar Allen scholarships or exhibitions for students of that University, of whom one-half shall be sons of workmen earning daily or weekly wages or foremen of workmen or managers. The gross value of the estate was 271,068*l*., and about 150,000*l*. is devoted to bequests for charities and employees.

THE annual gathering of the South-Western Polytechnic was held on Friday, March 12. The chair was taken by Archdeacon Bevan, and Mrs. Hayes Fisher distributed the certificates and prizes. The report of the principal showed that the chief feature of the session 1913–14 was the large number of scholarships gained by the past and present evening students. These scholarships included a Beit fellowship, the research studentship at Emmanuel College, Cambridge, a science scholarship and an art scholarship given by the London County Council. Amongst the degrees gained in London University were three D.Sc. degrees in chemistry. The principal also directed attention to the large number of present and past members of the institute who were serving with the forces. A vote of thanks was proposed by the Mayor of Chelsea, Principal Hudson, of St. Mark's College, and was seconded by Mr. J. B. Coleman, who gave some account of the present condition of chemical industries and of what the chemical department of the institute was doing to help those industries.

THE steady progress of education, and especially of scientific education, in India, has frequently been noticed in these columns, and we are glad to see confirmatory evidence in the *Presidency College Magazine*, issued from the Presidency College, Calcutta, and edited by Mr. Joges Chandra Chakravarti. The magazine contains some interesting papers and notes, and prominent among them is an article on Prof. H. E. Armstrong's visit to Calcutta as reader in chemistry to the University, when he delivered a course of five lectures. There is also a review of "Forty Years of Progress of Chemistry at the Presidency College," by Dr. P. C. Ray, showing how a school of chemical research is being gradually built up, of which Dr. Ray himself is the leader. A very appreciative obituary notice of Prof. J. A. Cunningham, who was professor of chemistry at the Presidency College from 1906–9 is given. Further, a series of notices of eminent Presidency College men is published, and the subject of the article in this number is Sir Asutosh Mookerjee, lately Vice-Chancellor of the University, who has done much for Indian education.

THE number of undergraduates in residence at Oxford and Cambridge, as stated in a note on March 4 (p. 24) is almost exactly one-third that of a year ago, the other two-thirds—about 2000 from each University—being on active service with the Army or Navy. According to the *Kreuz-Zeitung* there are upon the books of the twenty-two German universities—the twenty-second university being that of Frankfurt a/M., opened in October last—for the winter semester, including those at the front, 52,504 students, of whom 4000 are women, as against 59,600 and 3700 respectively last year. On leave—*i.e.* on military service—there are 29,882 students, including 300 women, mostly students of medicine. There are present in the universities 18,922 men and about 3700 women. Of those present, 1500, including several hundred women, are foreigners. The number of students on military service is, however, larger than appears from these statistics, since the Technical High Schools have not been taken into account. The real number is only obtained by subtracting from last year's number of German men students those of this semester, which gives about 32,000 students in the field. This does not even include those called to arms after the closing of the statistics Their number is at least one-third of those present, so that the number of students under arms must be raised by a further 6300. Seventy-five per cent. of the German students are therefore in the field. Of the German students of Technical High Schools about 80 per cent. are in the army.

THE War Office gives notice that an Army entrance examination will be held on June 29 next. At this examination there will be open to competition :—(*a*) Not fewer than 125 cadetships at the Royal Military Academy, Woolwich (for the Royal Artillery and Royal Engineers); (*b*) not fewer than 300 cadetships at the Royal Military College, Sandhurst (for the Cavalry, Foot Guards, Infantry, and Army Service Corps). The competition will be conducted in accordance with the regulations issued in November, 1911, except that no oral or practical tests will be included in the examination. To be eligible to compete for admission to the academy, a candidate's age must be such that he will have attained the age of 16½, and will not have attained the age of 25, on July 1, 1915. To be eligible to compete for admission to the college, a candidate's age must be such that he will have attained the age of 17, and will not have attained the age of 25, on that date. The contributions usually paid by parents of cadets will be dispensed with in the case of candidates admitted as a result of this examination. This will not affect the payment of 35*l*. required for the provision of uniform, books, etc. A sum not exceeding 3*s*. a day will be contributed from Army funds towards the cost of each cadet's messing, washing, and contingencies. Camp kits are issued in kind at the academy or college. Outfit allowance of 50*l*., from which the cost of the camp kit will be deducted, is issuable to cadets on appointment to commissions. A limited number of cadetships in the Royal Navy and supplementary first appointments in the Royal Marines will also be open to competition.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 4.—Sir William Crookes, president, in the chair.—Prof. W. A. **Bone**, Prof. H. L. **Callendar**, and H. J. **Yates**: A bolometric method of determining the efficiency of radiating bodies. In view of the increasing uses of incandescent surfaces in heating operations of all kinds, the authors have investigated, as a scientific problem, the measurement of radiant efficiencies of such surfaces, by a bolometric method, which can be standardised by direct comparison with a radio-balance, and which the authors propose to substitute for the existing *water-radiometer-cum-thermopile* method (known as the "Leeds method") used hitherto. The paper describes the construction and use of a new bolometer, specially designed for the purposes in view, in which the radiation from an incandescent surface, falling on a blackened coil of platinum wire, can be determined in absolute units for the increase in the electrical resistance of the receiving coil, the area of which is sufficiently small to allow of the instrument being standardised from a source of known intensity. And, by way of example, the application of the method to the measurement of both the absolute radiation of a gas fire and its "distribution factor," is described and discussed.—E. **Chappell**: The simplification of the arithmetical processes of involution and evolution. An arithmetical process can be said to be completely simplified when it is reduced to either addition or subtraction. The invention of logarithms completely simplified multiplication and division, but involution and evolution were only replaced by multiplication and division, so that these processes may still be laborious even with the use of logarithms. The paper describes a table of the logarithms of numbers recently compiled, by the use of which involution and evolution are also completely simplified. The frequency with which fractional indices, positive and negative, occur in most branches of modern experimental science gives rise to the hope that the tables in question will accomplish for the modern investigator what logarithms did for the man of science of the seventeenth century.—F. E. **Rowett**: The elastic properties of steel at moderately high temperatures. The difference in the behaviour of hard-drawn steel tubes, before and after annealing, under stress, led to the experiments described in the paper. At a suitable temperature a hard-drawn tube, which contains a good deal of amorphous material, behaves like a viscous fluid, that is, it flows more or less freely under stress, whereas, at the same temperature, an annealed tube being crystalline will flow in a much less degree, corresponding to the small amount of amorphous material in it. At a temperature of about 300° C. a hard-drawn tube shows properties similar to those of pitch at ordinary temperatures or of glass at a temperature rather below its softening point. It is still highly elastic under rapidly varying stress, but flows perceptibly when the stress is applied for a long time. On the other hand, in the annealed tube at 300° C. the energy dissipated in a cycle of stress is still almost independent of the time taken over cycle. At a higher temperature, for example, at 540° C., the hard-drawn tube flows rapidly and continues to flow for a long period, though at a diminishing rate, under a shear stress of less than one ton per square inch. Moreover, like pitch or glass, the steel at this temperature shows considerable elastic after-working. If the stress be suddenly removed the immediate elastic recovery is followed by a slow backward flow which persists for many minutes.—Prof. J. W. **Nicholson**: The laws of series spectra. The paper contains a critical analysis of the diffuse, sharp, and principal series of helium, especially in the light of recent interferometer measurements of the leading lines of these series. The investigation depends on a mode of accurate calculation of the limits of series, not dependent on the type of formula used. The limits of series with many lines, for which a Hicks formula is already known, can be calculated with extreme accuracy by a new method. Interferometer measures of leading lines of helium series enable the best form of the series to be obtained. This form is an extension of that of Rydberg, dependent on $m+\mu$ and not m. The value of Rydberg's constant, 109679·2, given by Curtis for hydrogen, is the true value for the arc spectrum of helium, and is, in fact, a rigorous constant for arc spectra. Spark spectra are not treated. The Rydberg-Schuster law of limits is exact for helium. It seems probable that μ is a simple fraction the denominator of which is a multiple of 5, as Halm has suggested. It is exactly 0·7 for the short series of helium.

March 11.—Sir William Crookes, president, in the chair.—E. **Heron-Allen**: Contributions to the study of the bionomics and reproductive processes of the foraminifera. The mechanical functions of the protoplasm in locomotion and food catching and its reaction to stimuli are considered. The phenomenon hitherto known as plastogamy is only fortuitously connected with reproduction, and is in most cases a budding-off of a daughter-individual from a parent shell. Certain species of foraminifera, if not all, vary the processes of reproduction by amœbulæ formed of protoplasm discharged from the shells, and by flagellispores, by the formation of fully formed and calcareously invested polythalamous young inside the parent shell which are set free by the resorption of the parent shell. The dual nature of the terminal chamber in *Cymbalopora brelloides*, d'Orbigny, is confirmed, and its functions in the life-history of the organism are discussed. A new species, *C. milletti*, Heron-Allen and Earland, is established. The species, *C. tabellaeformis*, Brady, is recorded as exhibiting a new phenomenon in the bionomics of foraminifera, namely, the excavation of crypts in suitable hosts where it passes its life, boring by chemical action tunnels for the protrusion of its pseudopodia. The secretion of calcium carbonate by porcellanous and hyaline foraminifera is considered, and the phenomena of "purpose" and "intelligence" are claimed as being exhibited by certain species of arenaceous foraminifera in the construction of their tests, either with a view to adaptation to environment or for defensive purposes. The "monadiform bodies" of Cymbalopora and the siliceous foraminifera from great depths, attributed to the late Sir John Murray, are explained by publication of his original notes made on board H.M.S. *Challenger*.—G. E. **Nicholls**: The occurrence of an intracranial ganglion upon the oculomotor nerve in *Scyllium canicula*, with a suggestion as to its bearing upon the question of the segmental value of certain of the cranial nerves. The occurrence of actively functional ganglion cells in large number, associated with numerous smaller and more deeply staining cells to form a small ganglion upon the oculomotor nerve in the adult *S. canicula*, has not hitherto been recorded. The true sensori-motor character of this nerve has recently been established by Sherrington and Tozer. This fact, in conjunction with the existence of the ganglion, becomes extremely significant, when it is remembered that the oculomotor plays an important part in the development of a related sympathetic ganglion (the ciliary). The author's suggestion is that the oculomotor be regarded as a distinct segmental nerve, not merely as a ventral root. From this it follows that the ophthal. profund. is not the dorsal root of the oculomotor neuromere, but has encroached upon that segment, while itself related to another (probably more posterior) head segment.—Prof. R. **Kennedy**: Experiments on the restoration of paralysed muscles by means of nerve anastomosis. Part III.—Anastomosis of the brachial plexus, with a consideration of the distribution of its roots. The experiments recorded consist of division of one or more roots of the brachial plexus and anastomosis of the divided root or roots either to another part of the plexus or to the spinal accessory. Restoration of function took place, and physiological examinations showed that this was due to the nerve which was substituted for the severed roots. When fewer than two roots were divided restoration of function took place much earlier, and was shown to be a spontaneous recovery due to the affected muscles being each supplied through more than one root.—A. F. S. **Kent**: The mechanism of the cardiac valves—a preliminary communication. The communication deals with the structure and mode of action of the auriculo-ventricular valves of the mammalian heart. Muscular tissue derived from the auricular wall runs for a considerable distance into the substance of the valve flaps, being situated principally towards their auricular surfaces. It is permissible to conclude that this muscle exercises an important function in connection with the closure of the valves. Receiving its stimulus from the base of the auricle, of which it is indeed an extension and with which it is directly connected, it comes into action at the appropriate moment in the cardiac circle, and contracts—and remains contracted—last of all the auricular muscle. Thus it keeps the valve flaps away from the ventricular wall, and ensures free play to the retro-valvular eddy right up to the time when the valve closure begins to be finally accomplished. The function of the muscular slips now described may be regarded as a double one—(*a*) to keep the flaps away from the ventricular walls, and thus to ensure the provision of an adequate space between the flap and the ventricular wall for the full development of the retro-valvular eddy, and (*b*) to afford by their contraction direct mechanical assistance in the raising of the flaps into the position of final closure.

Geological Society, February 24.—Dr. A. Smith Woodward, president, in the chair.—Dr. J. E. **Marr**: The Ashgillian succession in the tract to the west of Coniston Lake. The author has studied in detail the succession of the Ashgillian strata in Ashgill Beck and the adjoining tract. An account of the lithological characters and lists of the fossil contents of the various divisions are given, and confirmatory sections from Coniston Village to Appletreeworth Beck are described. A comparison is made with the beds of the Cautley district, previously described by the author. Some fossils which have not yet been found in the Lower Ashgillian of the Cautley district occur in the beds of that division at Coniston. From a study of the fossils of the Coniston tract and of other areas in Britain and the Continent, it would appear that a twofold division of the Ashgillian strata which is of more than local value may be made. The lower division is characterised by the abundance of *Phillipsinella parabola*, and the upper by the profusion of *Phacops mucronatus*.—H. S. **Shelton**: The radio-active methods of determining geological time. The author holds that the radio-active method of determining geological time, while of great interest, is not of such certainty as to be independent of confirmation from other lines of investigation. The various radio-active methods, helium ratios, lead ratios, and pleochroic haloes are severally examined, and the various sources of uncertainty, general and particular, are pointed out. The most important general cause of uncertainty is to be found in the fact that mechanical and chemical changes of composition in minerals are the rule rather than the exception; and, in instances where constancy of composition throughout long periods of geological time is asserted, the burden of proof lies with those who make the assumption. The attempt to assess exact, or even approximate times by means of lead ratios is premature and entirely invalid. At the same time, the weight of the evidence is such as to render it exceedingly probable, so far as radio-active evidence goes, that geological time must be reckoned at least in hundreds of millions of years. There is a high degree of improbability that the errors in the radio-active methods should always be errors of over-estimation. The next step in the investigation of the time problem is to be found in a reversion to other lines of reasoning. The sea-salt methods, and those based on the thickness of the sedimentary rocks in particular, need careful reconsideration. Reference is made to a number of papers which show that the first of these is worthless, and the second based on a misapprehension of the nature of deposition. The argument from tidal retardation is still of value, as also is that from the evolution of carbonate of lime. To the author radio-active experiments come as a confirmation of views held on other grounds, but are not sufficiently important in themselves to be authoritative against the balance of the evidence derived from other lines of investigation.

Mathematical Society, March 11.—Sir Joseph Larmor, president, in the chair.—Prof. E. W. **Hobson**: Some theorems in the theory of series of orthogonal functions.—Major P. A. **MacMahon**: Investigations in the theory of the partition of numbers by a new method of partial fractions.—Col. R. L. **Hippisley**: Reciprocal and parallelogram linkages.—Dr. J. R. **Wilton**: A pseudo-sphere the equation of which is expressible in terms of elliptic functions.—T. C. **Lewis**: Circles and spheres, etc., associated with a triangle, orthocentric tetrahedron, etc.

PARIS.

Academy of Sciences, March 8.—M. Ed. Perrier in the chair.—The President announced the death of Prof. Hittorf, foreign associate.—A. **Leduc**: Diffraction phenomena and the motion of the earth. Pointing out an error in the calculations of Mascart in his memoir on the modifications undergone by light by reason of the movement of the source or the observer.—Emile **Saillard**: Catalysis in the oxidation of the alkaline sulphites. The oxidation of alkaline sulphites is retarded by the presence of saccharose, invert sugar, and other bodies, and accelerated by rise of temperature. The practical bearing of these observations on the process of sugar refining is discussed.—Maurice **Lugeon** and Gerhard **Henny**: The Canavese zone and the southern limit of the Alps.—Med. **Gard**: A hybrid of *Fucus ceranoides* and *F. vesiculosus*.—M. **Weinberg**: Researches on gas gangrene. In the majority of cases the organism producing the disease is *B. perfringens*. A description of the preparation of a vaccine and an antiserum (through the horse) is given; the latter appears to offer the most promising results.—Agasse **Lafont**, M. **Desmoulins**, and F. **Heim**: Pneumokoniosis in metal polishers.

BOOKS RECEIVED.

A Handbook to the Collection of Kaolin China-Clay and China-Stone in the Museum of Practical Geology, Jermyn Street, London, S.W. By J. A. Howe. Pp. viii+271. (London: H.M.S.O.; E. Stanford, Ltd.) 3*s*. 6*d*.

A Pocket Synopsis of the Families of British Flowering Plants (Based upon the System of Engler). By W. B. Grove. (Manchester University Press; London: Longmans and Co.) 1*s*. net.

A Birdlover's Year. By the Hon. Gladys Graham Murray. Pp. viii+150. (London: Eveleigh Nash.) 3*s*. 6*d*. net.

My Life. By Sir Hiram S. Maxim. Pp. ix+322. (London: Methuen and Co., Ltd.) 16*s*. net.

Annuaire Astronomique et Météorologique pour 1915. Pp. 436. (Paris: E. Flammarion.)

Carnegie Institution of Washington. Year Book No. 3, 1914. Pp. xvi+399. (Washington: Carnegie Institution.)

The Idols. By R. Rolland. Pp. 12. (Cambridge: Bowes and Bowes.) 6*d*. net.

A Manual of Oils, Resins, and Paints. By Dr. H. Ingle. Vol. i. Analysis and Valuation. Pp. 129. (London: C. Griffin and Co., Ltd.) 3*s*. 6*d*. net.

Geometry of Building Construction. Second Year Course. By F. E. Drury. Pp. xii+226. (London: G. Routledge and Sons, Ltd.) 3*s*. net.

Canada. Department of Mines. Mines Branch. Gypsum in Canada: its Occurrence, Exploitation, and Technology. By L. H. Cole. Pp. x+256. (Ottawa: Government Printing Bureau.)

Canada. Department of Mines. Geological Survey. Memoir No. 38. Geology of the North American Cordillera at the Forty-ninth Parallel. By R. A. Daly. Part i. Pp. xxvii+546. Part ii. Pp. xxvii+547–857. Part iii. Sheets 17. (Ottawa: Government Printing Bureau.)

The Counties of Moray and Nairn. By C. Matheson. Pp. x+139. (Cambridge: At the University Press.) 1*s*. 6*d*. net.

The Counties of Clackmannan and Kinross. By J. P. Day. Pp. viii+145. (Cambridge: At the University Press.) 1s. 6d. net.

The Teaching of Geography. By B. C. Wallis. Pp. viii+221. (Cambridge: At the University Press.) 3s. 6d. net.

Molecular Association. By Dr. W. E. S. Turner. Pp. viii+170. (London: Longmans and Co.) 5s. net.

Ancient Hunters and their Modern Representatives. By Prof. W. J. Sollas. Second edition. Pp. xxiii+591. (London: Macmillan and Co., Ltd.) 15s. net.

Sun Lore of All Ages. By W. T. Olcott. Pp. xiii+346. (New York and London: G. P. Putnam's Sons.) 10s. 6d. net.

English Folk-Song and Dance. By F. Kidson and M. Neal. Pp. vii+178. (Cambridge: At the University Press.) 3s. net.

German Culture: The Contribution of the Germans to Knowledge, Literature, Art, and Life. Edited by Prof. W. P. Paterson. Pp. x+384. (London and Edinburgh: T. C. and E. C. Jack.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 18.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: X-rays and Crystals: Prof. W. H. Bragg.

ROYAL INSTITUTION, at 3.—The Form aod Structure of the London Basin: Dr. A. Strahan.

ROYAL SOCIETY OF ARTS, at 4.30.—The Indian Army: Lieut.-Colonel A. C. Yate.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual General Meeting—Presidential Address: Sir Thomas Kirke Rose.

LINNEAN SOCIETY, at 5.—Hollow-shafted Feathers: W. M. Webb.—The Lichens of South Lancashire: J. A. Wheldon and W. G. Travis.—Coloured Drawings and Lantern Slides of 36 British Orchids: E. J. Bedford.—A Few Australian Plants: Dr. A. B. Rendle.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Internal Combustion Engine on the Oilfield: F. G. Rappoport.

INSTITUTE OF METALS, at 3.—A selection of the following papers:—Some Experiments upon Copper-Aluminium Alloys: J. H. Andrew.—The Constitution of the Alloys of Copper with Tin. Parts I. and II.: J. L. Haughton.—Etching Re-Agents and Their Applications: O. F. Hudson.—The Effects of Heat and of Work on the Mechanical Properties of Metals: Prof. A. K. Huntington.—The Quantitative Effect of Rapid Cooling upon the Constitution of Binary Alloys. Part III. (Conclusion): Dr. G. H. Gulliver.—The Properties of Some Nickel-Aluminium and Copper-Nickel-Aluminium Alloys: Prof. A. A. Read and R. H. Greaves.—Some Appliances for Metallographic Research: Dr. W. Rosenhain.—The Micro-Chemistry of Corrosiun. Part III. The Alloys of Copper and Zinc: S. White.

FRIDAY, MARCH 19.

ROYAL INSTITUTION, at 9.—The Modern Piano Player—Scientific Aspects: Prof. G. H. Bryan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Chemical and Mechanical Relations of Iron, Cobalt, and Carbon: Prof. J. O. Arnold and Prof. A. A. Read.

INSTITUTE OF METALS, at 10.30 a.m. and 3 p.m.—A Selection of the Papers enumerated above.

SATURDAY, MARCH 20.

ROYAL INSTITUTINN, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

MONDAY, MARCH 22.

ROYAL SOCIETY OF ARTS, at 8.—Honse Building: M. H. Baillie Scott.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Spitsbergen in 1914: Dr. W. S. Bruce.

TUESDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—The Belief in Immortality among the Polynesians: Sir J. G. Frazer.

ZOOLOGICAL SOCIETY, at 5.30.—Exhibition of Partridges and other Game Birds: W. R. Ogilvie-Grant.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XVI. On Certain Points in the Anatomy of the Genus *Amabilia* and of *Dasyurotaenia*. Dr. F. E. Beddard.—The True Coracoid: R. Lydekker.—The Artificial Formation from Paraffin Wax of Structures resembling Molluscan Shells: J. T. Cunningham.—On Two new Species of *Polyplax* (Anoplura) from Egypt: Bruce F. Cummings.

INSTITUTION OF CIVIL ENGINERRS, at 8.—*Discussion:* The Improvement of the River Clyde and Harbour of Glasgow, 1873–1914: Sir Thomas Mason.—*Probable Paper:* On Impact Coefficients for Railway Girders: C. W. Anderson.

WEDNESDAY, MARCH 24.

ROYAL SOCIETY OF ARTS, at 5.30.—The Work of the War Refugees' Committee: Lady Lugard.

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—The Watertight Subdivision of Ships: Prof. J. J. Welch.—The Increase of Safety Afforded by a Watertight Deck: K. G. Finlay.—At 3 p.m.—The Influence of Discharging Appliances on the Design of Large Ore-Carriers: J. Reid.—The Scantlings of Light Superstructures: J. Montgomerie.—On the Strength and Spacing of Transverse Frames: C. F. Holt

GEOLOGICAL SOCIETY, at 8.—The Stratigraphy and Petrology of the Lower Eocene Beds of the North-Eastern Part of the London Basin: P. G. H. Boswell.

THURSDAY, MARCH 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On Forms of Growth resembling Living Organisms and their Products slowly deposited from Metastable Solutions of Inorganic Colloids: Prof B. Moore and W. G. Evans.—The Production of Growths or Deposits in Meta-stable Inorganic Hydrosols: Prof. Moore.—A Contribution to onr Knowledge of the Chemistry of Coat-Colour in Animals and of Dominant and recessive Whiteness: H. Onslow.

ROYAL INSTITUTION, at 3.—The Ground beneath London: Dr. A. Strahan.

CHILD STUDY SOCIETY, at 6.—The Care of the Teeth: C. E. Wallis.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephone Troubles in the Tropics: W. L. Preece.

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—A Contribution to the Theory of Propulsion and the Screw Propeller: F. W. Lanchester.—A Comparision between the Results of Propeller Experiments in Air and Water: A. W. Johns.—Further Model Experiments on the Resistance of Mercantile Ship Forms: The Influence of Length and Prismatic Coefficients on the Resistance of Ships: J. L. Kent.—At 3 p.m.—The Law of Fatigue Applied to Crankshaft Failures: C. E. Stromeyer.—The Effect of Beam on the Speed of Hydro-Aeroplanes: L. Hope.—Notes on the Cross Cnrves and GZ Curves of Stability: E. F. Spanner.

FRIDAY, MARCH 26.

ROYAL INSTITUTION, at 9.—Experiments in Slow Kathode Rays: Sir J. J. Thomson.

GEOLOGISTS' ASSOCIATION, at 8.—On the Structure of the Eastern Part of the Lake District: J. F. N. Green.

SATURDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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THURSDAY, MARCH 25, 1915.

PSYCHOLOGY WITHOUT CONSCIOUSNESS.

Behavior: An Introduction to Comparative Psychology. By Prof. J. B. Watson. Pp. xii+439. (New York: H. Holt and Co., 1914.) Price 1.75 dollars.

BY the nature of its subject-matter, psychology has been more handicapped than any other science as regards both methods and aims. This is a truism which may qualify the following statement of Prof. Watson: "Psychology has failed signally during the fifty odd years of its existence as an experimental discipline to make its place in the world as an undisputed natural science." He is quite justified in saying that psychology "as it is generally thought of, has something esoteric in its methods. If you fail to reproduce my findings, it is not due to some fault in your apparatus or the control of your stimuli, but it is due to the fact that your introspection is untrained. . . . If you can't observe 3—9 states of clearness in attention, your introspection is poor. If, on the other hand, a feeling seems reasonably clear to you, your introspection is again faulty. You are experiencing too much." This kind of psychological method has been particularly exploited by the Germans. Again, the science has almost evaporated "in speculative questions concerning the elements of mind, the nature of conscious content (*e.g.*, imageless thought, attitudes and *Bewusstseinslage*, etc.)"; a practical result is that the concept of sensation is "unusable, either for the purpose of analysis or that of synthesis." Generally, the axiom that psychology is a study of the phenomena of consciousness has been thoroughly mischievous; no data have been accorded any importance except in so far as they throw light upon conscious states. Compromises have been attempted; a line has been tentatively drawn where "associative memory" in animals begins; consciousness has been assumed to commence where "reflex and instinctive activities fail properly to conserve the organism," or "whenever we find the presence of diffuse activity which results in habit-formation, we are justified in assuming consciousness." Not the least result of such pre-suppositions is the divorce of the study from practical human interests.

The new school of what Prof. Watson terms "behaviorism" has, as his volume well shows, thrown overboard much conceptual lumber of the sort sketched above, and comparative psychology is able to act untrammelled. "It is possible to write a psychology (as the 'science of behavior') and never go back upon the definition; never to use the terms consciousness, mental states, mind, content, will, imagery, and the like. . . . It can be done in terms of stimulus and response, in terms of habit formation, habit integration, and the like." The starting-point is the observable fact that "organisms, man and animal alike, do adjust themselves to their environment by means of hereditary and habit equipments; . . . . certain stimuli lead the organisms to make the responses." Thus, with the elimination of investigational reference to consciousness, mental state, or imagery (as previously such reference to soul and mind (its successor) had been discredited), the barrier between psychology and objective sciences is removed; "the findings of psychology become the functional correlates of structure and lend themselves to explanation in physico-chemical terms." "The behavior of man and the behavior of animals must be considered on the same plane."

This latest reforming of the comparative psychological front may be considered strategically sound, and should lead to advances along all the line. Little has been accomplished yet, but the resulting clearness of objective is already promising. For instance, Prof. Watson's discussion of the differences between man and animal; convolution of brain surface probably means nothing *per se*. Wundt assumed that the apperception centres resided in the frontal lobe; for this view there is no probability, but since the frontal lobe "was the last brain tissue put on in evolution, and is to be found chiefly in man, we have hastened to assign to its care all those functions in which man is thought chiefly to excel the brute." The break between man and brute is "the lack of well-developed speech mechanisms in animals and the consequent lack of *language habits*. . . . The lack of language habits forever differentiates brute from man."

The general reader and the beginner in comparative psychology will find this impartial and well-reasoned volume invaluable. Some of the best matter is the result of the author's own experiments, *e.g.*, with terns, monkeys, and rodents.

A. E. CRAWLEY.

WATER, SEWAGE, AND FOOD.

(1) *The Chemical Examination of Water, Sewage, Foods, and other Substances.* By J. E. Purvis and T. R. Hodgson. Pp. 228. (Cambridge: At the University Press, 1914.) Price 9*s*. net.

(2) *Water Supplies: their Purification, Filtration, and Sterilisation. A Handbook for the Use of*

Local and Municipal Authorities. By Dr. S. Rideal and Dr. E. K. Rideal. Pp. xii+274. (London: Crosby Lockwood and Son, 1914.) Price 7*s.* 6*d.* net.

These two books to some extent supplement one another, the former dealing with the analysis of water (among other things), while the latter treats mainly with the production of a pure and wholesome water supply; the one being designed for the analyst and public-health student, the other for local and municipal authorities.

(1) The volume by Messrs. Purvis and Hodgson, as its name implies, deals primarily with the chemical analysis of water, sewage and foods, and such allied subjects as the detection and estimation of preservatives, and the analysis of air, coal-gas and other gases, rag flock, and urine.

The opening chapter, which is by far the longest in the book, deals with the analysis of water, sewage, and sewage effluents. More or less detailed descriptions are given of the chief tests employed, and in this connection one might note the desirability of the standardisation of some of these tests, notably those for albuminoid ammonia, and oxygen absorbed from permanganate. Some of the tests, as described, do not appear to be capable of any great delicacy. This is particularly the case with the ammonia tests, which apparently are about ten times less delicate than those employed in the laboratories either of the Metropolitan Water Board or the Royal Commission on Sewage Disposal.

At the conclusion of the chapter the results of a series of investigations, chiefly by Mr. Purvis, are given dealing with the effect of mixing sewage with river water and sea water. Much of the work is obviously inspired by the eighth report of the Royal Commission on Sewage Disposal. The researches have resulted in some interesting information, but the manner in which the results are presented makes a full appreciation of them very difficult, and some of the results of an investigation of the changes which occur to a mixture of sewage and sea water in course of time show such wide variations that one is inclined almost to doubt the accuracy of some of the figures; for example, the albuminoid ammonia of a mixture of sewage and sea water analysed after 115, 165, and 176 days is given as 0·078, 0·002, and 0·13 respectively (Table F^1, p. 74).

The remaining chapters of the book consist of instructions for carrying out the analyses of the other substances mentioned above. The instructions are usually remarkably clear and concise, but occasionally they become much involved and even ungrammatical, suggesting that these parts have been hurriedly compiled. This, however, is a small blemish, and can easily be corrected in a future edition; it in no way detracts from a book which will undoubtedly be of great value both to the analyst and the student in a public-health laboratory.

(2) The second volume under review deals with the question of water supply in its widest sense, and only touches on the subject of analysis in the last chapter, and then more on the interpretation of the results than on the way these results are obtained.

The opening chapters deal with the inorganic and organic contents of natural waters, both useful (as in medicinal springs) and harmful (as in water from polluted sources), mention being also made of some of the living contents, particularly those grouped under the name of plankton. Following this preliminary matter, the book deals with the successive stages in water supply under the headings of sources of supply, distribution, storage, filtration, softening, sterilisation, and finally the analysis of water and interpretation of results.

There is so much of interest in this valuable book that it is difficult, in the space allotted, to more than mention many of the important subjects dealt with, but several points call for especial notice.

The chapter devoted to storage is full of interesting information, particularly with regard to the physical, chemical, and bacteriological changes which occur in water subjected to storage. It is pointed out, for instance, that while the changes which occur to an initially impure water are wholly or mainly in the direction of improvement, an initially pure water may considerably deteriorate owing to prolonged storage.

Before going into the important subject of filtration, the authors devote a chapter to preliminary purification, including precipitation and assisted sedimentation, deferrisation, and the abatement of nuisances arising from living growths in the reservoirs; this subject is treated very fully, and reference is made to the work of many investigators both English and foreign.

Chapters vii. and viii. deal in great detail with the question of sand filtration and mechanical filtration, chapter ix. with softening, and then follow two important chapters on sterilisation.

The authors enter a strong plea for the sterilisation of all supplies from polluted or pollutable sources. Against the contention that the expense of sterilising is prohibitive in a great many cases, the suggestion is put forward that there might be a dual supply for drinking and non-potable purposes, but the arguments in favour of this course do not seem to be very convincing; moreover, the alternative to sterilisation put forward by Dr. Houston in his reports to the Metropolitan Water Board—namely, adequate storage followed by efficient filtration—is not presented in its best light, and one is inclined to think a much better case could be made out from Dr. Houston's reports in favour of his suggestions than is conveyed by the somewhat meagre extracts given in the book.

The different means of sterilising water are very fully described and discussed, both chemical (peroxides, excess lime, chlorine, and hypochlorites, etc.), and physical and electrical (electrolytic hypochlorite, ozone, and ultra-violet light), and full reference is made to the places where these processes are practised.

The concluding chapter, on the analysis of water and the interpretation of results, is written more for the water authority than the analyst. It is not an easy subject to deal with, yet the authors appear to have done it very carefully.

There are numerous excellent plates in the book illustrating different works and processes.

DENISON B. BYLES.

RADIOLOGY IN THEORY AND PRACTICE.

(1) *X-rays: an Introduction to the Study of Röntgen Rays.* By Dr. G. W. C. Kaye. Pp. x+252. (London: Longmans, Green and Co., 1914.) Price 5*s*. net.

(2) *A Manual of X-Ray Technic.* By Capt. A. C. Christie. Pp. viii+104. (Philadelphia and London: J. B. Lippincott Company, n.d.) Price 8*s*. 6*d*. net.

(3) *Molecular Physics.* By J. A. Crowther. Pp. viii+167. (London: J. and A. Churchill, 1914.) Price 3*s*. 6*d*. net.

(1) THE discovery of X-rays has hitherto afforded an opportunity, probably unique in the history of science, for the production of that kind of literature which is distinguished more for its sensational character than for its accuracy or usefulness. If the numerous small books and pamphlets dealing with the subject and published between 1895 and 1898 do not seem to us now to possess any striking feature, they are at least remarkable for their resemblance to one another. They serve, too, as a measure of the wide popular interest aroused by Prof. Röntgen's work. Some of these publications actually reached the six thousandth edition before finally sinking into oblivion. When it was realised, however, that X-rays, in conjunction with the study of radioactivity, were destined to play a vital part in the elucidation of many problems hitherto considered insoluble, and a few well-known laboratories had successfully taken the matter in hand, the budding heralds of a new physics seem to have lost their spirit. It is noteworthy that from about 1898 until now, excepting some medical works, including an account of radiation treatment, no English book has appeared devoted solely to the systematic study of Röntgen radiation.

Dr. Kaye's book will therefore be welcomed by all who are engaged in work with the new radiations generally and with X-rays in particular, for it has appeared at the very moment when it is most needed.

The time has certainly come to take stock of our knowledge of this subject and to set forth clearly the relationship which connects the speed of the electron with the wave-length of the radiation resulting from its impact against a specific substance. Incidentally, it is seen that the production of a radiation identical with the gamma rays from radium is merely a question of overcoming certain experimental difficulties, and obstacles of this character generally disappear with the lapse of time. The first part of Dr. Kaye's book deals in an interesting manner with some of the early classical vacuum-tube experiments, and care is taken, by the aid of numerous asides in the form of footnotes, to give the reader many useful facts as well as references.

The fourth chapter deals with the X-ray bulb itself, and the progressive changes in its design are traced from the 1895 type, with flat electrodes, up to the somewhat elaborate modern apparatus. There are many excellent illustrations here, and the photomicrograph on p. 43, of an anti-kathode after prolonged use, is of great interest. A chapter follows in which the various high-potential generators of electricity are described. The references to influence machines, induction coils, and step-up transformers contain many practical hints, and the oscillograph records are well reproduced. Next follows an account of the various interrupters and their several virtues or drawbacks, and a chapter dealing with the actual manipulation of an X-ray apparatus, wherein we are told about the volatilisation of the anti-kathode, the coloration of the glass, and so forth—all of great practical interest and importance to these engaged upon this work. The rest of the book is concerned with the more theoretical part of the subject and methods of measurement, questions of wave-length, sparking potentials, absorption coefficients, and so on. The work of Barkla and others on the secondary and characteristic radiations are fully set out, so that the reader may be gradually prepared for the final sections dealing with the actual nature of X-rays and the discussion of recent work upon their reflection from the interior of crystals.

Although we do not agree with the footnote to p. 165, the application of X-rays to medicine is mentioned with a moderation which will be understood and appreciated by those who are expert in that branch of the subject. We have no hesitation in recommending that a copy of the book should be in the library of every medical practitioner who desires to master the fundamental ideas underlying the properties and actions of the radiation which he is putting to good use in the alleviation or cure of disease.

(2) The study of the clinical application of X-rays is more often than not approached from a purely medical point of view, and some there are who think that a wider scientific knowledge, especially of physics, should play a large part in the early training of the student of radiology. It is probable that with them at least this book will find no favour; indeed, were it not for the fact that the author states specifically in his preface, for whom this book is intended some doubt upon the point might reasonably have arisen.

It must be borne in mind, however, that we have to deal here with a manual intended to meet the "needs of the United States army," and, judging by the somewhat limited knowledge of the subject considered sufficient in our own service, a student who assimilates the contents of this work might be counted as one possessing exceptional qualifications.

If "brevity is the soul of wit," it may also be the source of much error, and the inadequate treatment of the elements of electricity and magnetism condensed into the first nine pages contains some misleading statements. From chapter iii. onwards, however, there will be found many useful practical hints as to radiographic technique, and the tersely written survey (which certainly covers a wide field) affords a suitable framework upon which to build by experience if supplemented by the study of more complete works dealing with the subject.

(3) It is noteworthy that in this small handy volume Mr. Crowther has succeeded in giving a remarkably complete survey of work dealing with the physics of the electron and atomic structure.

The treatment of the subject is naturally influenced very largely by the trend of researches carried out during the last few years at the Cavendish Laboratory, and the work therefore stands as an authoritative and connected account of the most important recent results which have emanated from Cambridge under the stimulating leadership of Prof. Sir J. J. Thomson. The new method of analysis, for instance, which depends upon the simultaneous deviation of positive particles by an electrostatic and magnetic field, is dealt with in considerable detail and the apparatus illustrated by photograph and diagrams. There are also chapters devoted to the nature and size of electrons, their group stability, cohesion, and adhesion, as well as the bearing of modern physics upon valency and other problems once thought to be the exclusive preserves of the chemist. In the midst of great detail the author has nevertheless marked out clearly the general lines upon which this important subject has rapidly developed in recent years, and has brought together into a connected whole the results of work from many sources. It is difficult to select any particular section for special mention where all are so well done, but the chapter dealing with the atom in vibration is certainly of particular interest.

The author then shows the far-reaching significance of these new experimental results by directing attention to their bearing upon the complex "molecular theory of matter" as applied to solids, liquids, and gases. In the later pages he refers to the kinetic theory of heat, the size of atoms, and many other questions of wide interest and importance at the present day. The book, so well conceived, is a veritable mine of information. It will be read by physicists with only one regret—the author has not included even the briefest index.

C. E. S. P

OUR BOOKSHELF.

Economic Cycles: Their Law and Cause. By Prof. H. L. Moore. Pp. viii + 149. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

In this volume Prof. Moore has undertaken to test statistically the theory that the fundamental cause of that curious swing in trade, which results in alternate periods of depression and expansion instead of steady growth or decline, is a corresponding cycle in the weather, operating through its effect on the crops. Rainfall data for the Ohio valley are subjected to harmonic analysis, and the periodogram shows principal periods of thirty-three and eight years. These periods and their semiharmonics applied to the statistics of yield and production for some of the principal crops suggest that they will also account for the principal fluctuations in quantity, as might be expected from the high correlation between the yield and the rainfall of the months that are critical for each crop. Changes in yield are also highly correlated with changes in price for the several crops, and hence the general relation of the crop-cycle to the cycle of prices and trade in general—though matters are not so simple as might be thought at first sight, for in some manufacturing industries, *e.g.*, the production of pig-iron, price and production rise and fall together.

As in the case of his volume on the "Laws of Wages," Prof. Moore brings a distinct freshness of view to his task, and has made an important contribution to the subject with which he deals. What one most misses is any reference to the labours of others who have preceded him in the same field, and rendered the hypothesis one that many have already accepted, though some of them may only be willing to regard the weather-cycle as a contributory cause.

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Second edition. Pp. viii+102. (London: Longmans, Green and Co., 1915.) Price 3*s*. net.

THIS is a useful little laboratory manual, in which the author states he has departed from the method usually employed. This departure may be illustrated by an example; there are certain tests for starch; it is usual to take commercial starch and perform the tests with this; the student is generally instructed also to prepare enough starch from the potato to illustrate its microscopic appearances. Dr. Cramer adopts the method of starting with the potato, and instructs his pupils to prepare from it enough starch for macroscopic experiments also. The distinction between the two methods is rather apparent than real, and Dr. Cramer's method involves more trouble to the student, which may not be a bad thing. Another departure one notices is that the results of a reaction are not explained; he interpolates instead questions such as, what change occurs? or why is this? or explain the result. This plan of stimulating inquiry is an excellent one for the student above the average; but one fears that 95 per cent. of the class will leave the questions unanswered, and be content with their ignorance. The author, moreover, is not consistent in the use of this method of questioning; one notes, for instance, in such subjects as blood-clotting and nerve chemistry, subjects on which Dr. Cramer holds special views of his own, that the teaching is didactic; it would evidently be unsafe to leave students here free to pursue independent inquiry.

W. D. H.

Soil Conditions and Plant Growth. By Dr. E. J. Russell. Pp. viii+190. New edition. Monographs on biochemistry. (London: Longmans, Green and Co., 1915.) Price 5*s*.

THE first edition of Dr. Russell's book was reviewed in the issue of NATURE for October 24, 1912 (vol. xc., p. 215). To the new edition a chapter has been added on the relationship between the micro-organic population of the soil and the growth of plants, and also a number of sections dealing with recent developments of other parts of the subject.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, 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.*]

Early Figures of the Opossum.

IN view of the fact that several communications have appeared in NATURE during the past year concerning the first mention of the American opossum in literature, it may not be inopportune to direct attention to some of the early illustrations of this animal in maps and in printed works. First of all, it should be stated that the earliest reference to the opossum is found in the famous collection of voyages known as "Paesi Novamente Retrovati," published in 1507. In chapter cxiii. of that work it is mentioned that a live specimen, taken by the Pinzons in Brazil in 1500, was exhibited in Granada.

In the Waldseemüller map of 1516 a drawing intended to represent the opossum, as indicated by its accompanying legend, is introduced in the Brazilian region of South America; and this figure is copied in a number of later maps, and also in the Italian edition (1558) of Sebastian Münster's "Cosmographia."

FIG. 1.

Under the native designation of "Su," a grotesque figure of the opossum was given by André Thevet, in his volume published in 1558, and in the same year appeared the "Wahrhaftig Historia" of Hans Stade, of Homburg, wherein occur (cap. xxxi.) two illustrations, and descriptions, of these Brazilian animals, one of which is called the "Servoy" (*Didelphis marsupialis*, L.) and the other "Dattu" (*Dasypus novemcinctum*). The descriptions read as follows:—

"There is also a kind of game, called servoy, which is as large as a cat, and has a tail like a cat; its fur is gray, and sometimes grayish black. And when it breeds, it bears five or six young. It has a slit in the belly about half a span in length. Within the slit there is yet another skin; for its belly is not open, and within this slit are the teats. Wherever it goes, it carries its young in the pocket between the two skins. I have often helped to catch them and have taken the young ones from out of the slit."

"There is another sort of animal found in this country which the savages call *dattu*; it stands about six inches high and is nine inches long; its body is covered all over, except underneath, with a kind of armor. This covering is horn-like, and the plates overlap one another like those of chain armor. This animal has a very long snout, and is usually found on rocks. It feeds on ants. Its flesh is sweet and I have often eaten of it."

Several species of American marsupials are figured by seventeenth-century writers, such as J. E. Nieremberg (1635), George Marcgrav (1648), César de Rochefort (1658), and others. An illustration given by the last-named author is here reproduced (Fig. 1).

C. R. EASTMAN.

American Museum of Natural History.

Differential Antiseptic Action of Organic Dyes.

AN important property of certain organic dyes is their differential antiseptic action. Thus, varieties of *B. coli* commonly met with in the intestine are more susceptible to the inhibitory action of the tetraethyldiamidotriphenylmethane derivative, "brilliant green," than are typhoid or paratyphoid bacilli. The use of a fluid culture medium containing this dye (along with telluric acid) facilitates greatly the isolation of scanty typhoid and paratyphoid bacilli from fæces, since the growth of the various members of the *coli* group can be restrained, while the organisms in question proliferate actively. The detection of cases of typhoid infection, *e.g.* in "carriers," which is frequently a difficult bacteriological problem, can be materially simplified by this procedure. But our supplies of brilliant green have hitherto been derived from Germany, and I shall be indebted to your readers for information as to whether this dye is prepared in a fairly pure state by anyone in this country.

C. H. BROWNING.

The Bland-Sutton Institute of Pathology,
The Middlesex Hospital, London, W.

The Physical Properties of Isotopes.

DR. LINDEMANN (NATURE, March 4) deduces that the vapour pressure of lead from radio-active origin, or of radium D, should be very considerably different from ordinary lead at comparatively low temperatures. It would be no easy matter to test this at such a low temperature as 100° C. However, it is being found possible to make measurements of the vapour pressure of cadmium down to 10^{-6} mm., and the method should be applicable to the point in question.

It is interesting to note in connection with the last paragraph of Dr. Lindemann's letter that the arc spectra of lead of radio-active origin and of ordinary lead show no difference, as Mr. T. R. Merton has recently found, further confirming the view that the external electrons are responsible both for the spectra and the individual chemical properties of elements.

ALFRED C. EGERTON.

19 Old Court Mansions, Kensington.

A Misprint in Halphen's "Fonctions Elliptiques."

HAVING recently had to use Halphen's multiplication formulæ for the special cases of the lemniscate functions ($g_3=0$), I have convinced myself that there is a rather serious misprint in his expression for ψ_4 (vol. i., p. 96), namely, instead of $+\frac{1}{32}g_2^3$ in the last term, we should read $-\frac{1}{32}g_2^3$. Thus with $g_2=4$, and this correction, we have

$$\psi_4=\wp'(-2\wp^6+10\wp^4+10\wp^2-2)$$
$$=-2\wp'(\wp^2+1)(\wp^4-6\wp^2+1)$$

where the factor $(\wp^2+1)$ can be foreseen from the theory. With the other sign we have no such resolution.

G. B. MATHEWS.

Early References to Musical Sands.

AN allusion to musical sands may be found in one of the tales from the "Arabian Nights"—"The Story of the Two Sisters who were jealous of their Younger Sister." Prince Bahman, who was journeying in search of rarities and treasures, reaches the foot of a mountain, and while ascending "was assailed with the most hideous sounds," while others who followed him heard "groans, shouts, and all sorts of insulting epithets." One of the wonders they were in search of was the "Singing Tree," which "commenced to issue a series of exquisite strains of music" as soon as the Princess Parizadé saw it.

CECIL CARUS-WILSON.

March 21.

TWO CHINESE TOURS.[1]

A SOMEWHAT unexpected sequel to the mission which Sir Francis Younghusband led to Lhassa in 1903–4 was the appreciation by Chinese officials of the fact that the trade in Indian opium, which has at times been held up as a reproach to England, was in reality due to the demand of China for the drug. It is interesting to reflect that the truth should first have dawned upon a Chinese envoy who had been educated in the United States. The novel idea took root and engendered a movement which spread in China with such rapidity that in 1906 an imperial edict dealing with the opium question was promulgated. This rescript embodied elaborate provisions for the immediate curtailment and the gradual extinction of the use of the drug. Necessarily, therefore, it took account not only of the enormous Chinese out-turn of opium, but of the smaller, though still important amount imported from India. Proposals and counter-proposals were accordingly formulated in 1907 by the Governments of China and Britain, and certain regulations, to remain effective for three years, were agreed upon by the high contracting parties and became operative in 1908.

Meanwhile the Government of the United States thought fit to initiate a movement of an international character which culminated in the assembly at Shanghai in 1908 of an opium commission, the findings of which reflect a desire to aid the Chinese authorities in their crusade against the opium habit; while, before the preliminary period of three years had expired, negotiations for a new agreement between China and the United Kingdom were set on foot. As a preliminary to the ratification of this agreement it was desirable that his Majesty's Government should know what had been the actual effect in China of the restrictive measures adopted there in response to the imperial injunctions of 1906. The officer to whom the important duty of reporting upon this feature of the case was Sir Alexander Hosie. No one better fitted for the duty of traversing the six provinces of China, known to have been the chief opium-producing areas in that empire, could have been selected. Sir Alexander had already travelled extensively, and in some cases, as an officer of the Chinese Consular Service, had resided in the provinces

[1] "On the Trail of the Opium Poppy. A Narrative of Travel in the Chief Opium-producing Provinces of China." By Sir Alexander Hosie. 2 vols. Vol. i., pp. viii+300. Vol. ii., pp. 308. (London: G. Philip and Son, Ltd., 1914.) Price 25s. net 2 volumes.

involved. During a sojourn of more than thirty years in China he had taken a keen interest in all the economic resources of the empire; he had, moreover, been one of the members of the International Opium Commission which met at Shanghai. The narrative and the results of the two official journeys, undertaken with the object of securing the information of which the British Government had need, are given in the volumes now before us.

As the author in his preface explains, the book is not devoted to the history of the opium question. Nevertheless, those interested in that question will do well to consult this work. The circumstance that such consultants may neither be inclined nor qualified to appreciate the whole of the contents has been forestalled by the provision, for their especial benefit, of a couple of appendices wherein the genesis of the anti-opium crusade is outlined, and the results of his own investigations of 1910–11 into the cultivation of the poppy are summarised.

As compared with various other accounts of recent Chinese travel, an outstanding feature of the present work is the extent to which it deals with the conditions and the appearance of long-settled and closely cultivated portions of that empire. Having regard to the primary purpose of his two journeys this was inevitable, nor can the reader be too grateful to the author for the care and precision with which he recapitulates the various crops observed in the course of a particular stage. Even in districts where tilth is most intensive, however, areas occur which are unfit for cultivation, and are under timber. The components of the vegetation in cases of this kind are as carefully assessed as the field crops. In one such passage the author warns the reader not to assume, because reference has been made almost exclusively to trees of economic importance, that species of less consequence were altogether absent. The same may be true of other stages, as to which no such reservation is made. But even when due allowance is made for this possibility, one of the most interesting impressions which the narrative of the author conveys is the extent to which species that are devoid of utilitarian interest and value have become eliminated. The naturally regenerated constituents of the woodlands on uncultivated mountain slopes appear in the main to be as strictly economic as the species planted along highways and irrigation channels.

The detailed descriptions of the various stages should render the work useful to those who may follow the author's route, but the general reader will be most interested in, and will profit most from, the incidental accounts of the configuration, the industries, and the polity of the provinces traversed by him. A passage which excites interest and arrests attention deals with the famous Nestorian tablet at Hsi-an Fu in Shensi, while the temperate but convincing reference to the shortcomings of European cartography, the uniformity and simplicity of Chinese delimitations and terminology notwithstanding, evokes the reader's sympathy. Space forbids more than a passing reference to a few of the interesting topics discussed in the work. Among these may be mentioned the cultivation of huskless grain, the use of the fibres quaintly known to European commerce as China jute and China grass, the preparation of varnish, the weaving of silk, the making of bamboo hats, the wood-oil industry, the smelting of copper, the mining of coal, the separation of salt, the planting of rice, the various contrivances for irrigation, the different types of bridges. With these and other equally interesting topics the reader may best be left to make himself acquainted by reading the book. One of the most interesting passages in the work deals with the familiar yet little understood *loess* formation (Fig. 1), so extensively represented in the area traversed during the author's northern journey. Another, taken from the southern journey, treats of the white-wax industry (Fig. 2),

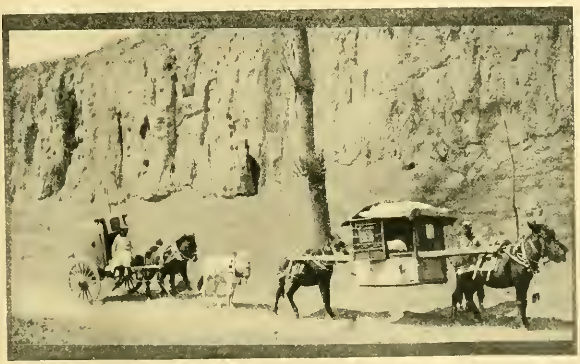

FIG. 1.—The loess formation, with mule litter and passenger cart, Shansi. From "On the Trail of the Opium Poppy."

FIG. 2.—Chinese ash (*Fraxinus Chinensis*) coated with insect white wax. From "On the Trail of the Opium Poppy."

for our knowledge of which we are mainly indebted to the author's powers of observation. These powers are so rarely at fault that it seems almost ungracious to indicate the only instance in which he appears to have been led into misapprehension; there is one passage in which what, from his succinct description, was obviously a silk-cotton tree has been confused with that—from a phytogeographical point of view—extremely interesting species, the tulip-tree of China. The book is admirably printed, and in its 600 or so pages we have noticed but one typographical error.

THE TELEPHONE IN SURGERY.

IN the *Lancet* of January 30 is published an address by Sir James Mackenzie Davidson, delivered before the Medical Society of London, on the telephone attachment in surgery. By this phrase the author refers to the attachment of a telephone receiver to a probe, or lancet, or other metallic instrument used by a surgeon when exploring a wound containing a bullet or other piece of extraneous metallic matter, in such a way that the sound heard in the telephone when the probe comes into contact with the bullet enables the surgeon to make certain of the position of the bullet in the wound.

As this matter appears to be of real importance at the moment to surgeons in the field hospitals of our armies abroad, we make no apologies for giving our readers a summary of the more salient features of Sir Mackenzie Davidson's address. His attention was first directed to the use of the telephone as an auxiliary in surgery thirty-two years ago, by the accounts of the attempts made by Graham Bell, to determine, by means of the induction balance, the position of the bullet in the body of President Garfield when he was assassinated in 1881. Speaking afterwards of these attempts, and of the difficulties attending the method—which had failed in that notable case to yield satisfactory indications—Graham Bell outlined another and simpler electrical method for the detection of bullets, as follows:—

> It consists of a telephone, to one terminal of which a fine needle is fixed, and to the other a plate of metal of the same nature as the needle. The plate is placed on the limb to be examined, and the needle is thrust in where the bullet is believed to be; and when it strikes the ball a galvanic battery is formed within the body. . . . *This will cause a click to be heard in the telephone each time the bullet is struck.* This is a far simpler apparatus than the induction balance, and one far more easily procured.

This method Sir Mackenzie Davidson tried in 1887 at the Aberdeen Royal Infirmary, in the case of a patient suffering from a revolver shot, using a silver probe joined by a wire to one terminal, and a silver plate, about 6 inches long and 4 inches wide, connected by wire to the other terminal of a telephone receiver. In subsequent years he employed the same method to verify the results of early X-ray localisations, and it enabled surgeons in the South African War to differentiate, as the common probe could not do, between a distorted and broken up Mauser bullet and a fragment of bone. Sir Mackenzie Davidson states that until quite recently he took it for granted that the same metal must be used—as Graham Bell stated—for the probing instrument and for the plate placed upon the patient's skin. But since the outbreak of the present war the difficulty experienced by skilful surgeons in finding bullets in wounds, even after the most precise localisation by means of X-rays, has caused him to experiment further, and to extend the method. Briefly, he finds, as the result of experimenting on different pairs of metals, that there is nothing so satisfactory as a plate of carbon, such as is used in an ordinary bichromate cell, to place upon the moistened skin of the patient as the auxiliary pole. The surgeon's metallic instruments are usually of steel, often silver-plated or nickel-plated. The metals to be sought for are lead, iron (and iron alloys), copper, and nickel. Carbon presents a sufficiently wide difference in its galvanic properties from any of these to render it suitable. The result is enhanced if the solution used to moisten the skin beneath the plate is the solution of iodine employed as a disinfecting agent, since iodine is also an excellent depolariser. A low-resistance telephone is better adapted than the more expensive high-resistance receivers used in wireless telegraphy, giving louder sounds besides being cheaper.

The form of telephone recommended is one with double receivers fixed to a flexible steel hoop that is placed on the head, so that each ear listens to its own receiver, and is protected from extraneous sounds. The operating surgeon places the auxiliary carbon plate upon the patient's moistened skin at some convenient spot near the place where the foreign object is supposed to be situated, and it may be held tightly against the skin by bandage or plaster. If a bare wire of silver is used as probe, it should, of course, be properly disinfected. Or the wire may be wound round an ordinary probe or needle or forceps which is used, or a spring clip may be employed to connect the instrument to the wire connected to the telephone. No battery of any kind is needed, owing to the galvanic action between the carbon-plate and the metal of the bullet. If, under these conditions, the instrument is introduced into the body of the patient, it will on the first contact with the bullet or other metallic body cause a most unmistakable click; while if the probe or scalpel is gently moved along the foreign body so as to make rubbing contact along it, an equally unmistakable rattling sound will be heard. Several examples of successful application, showing the advantages gained by the use of this method, are given by Sir Mackenzie, who states it to be his belief "that the time will come when no surgeon will attempt to remove a deeply embedded metallic body without having this telephone attachment at his command." He makes out an exceedingly good case for this application of the telephone to surgery.

The author's experience and ingenuity in applying X-ray methods to localise the position of foreign bodies are so well known that when he comes forward with improved methods of electric probing, which have the distinguishing merit of the utmost simplicity, we may be sure they will find immediate and extensive application.

GEODETIC SCIENCE.

NO. 3 of the new series of professional papers of the Ordnance Survey contains some excellent notes on the geodesy of the British Isles, by Colonel Close, R.E., which bring the position of geodetic achievement fairly up to date, and incidentally add some historical indications of the processes by means of which our position in the world of geodetic science has been secured. Their usefulness has been increased by the addition of a very ample bibliography of the science, and by simple diagrams illustrating certain special features affecting geodetic levelling, including the principal triangulation of Great Britain, the geographical position of the West European meridional arc, and of the European longitudinal arc. In the section of the pamphlet dealing with standard measurement it is interesting to observe that the national standard yard, which was legalised in 1855, consists of a marked length on a bronze bar bearing a definite relationship to the "international" metre (also a measured length on a bar), which was originally intended to represent one ten-millionth of the length of the earth's meridional quadrant.

Colonel Close's sketch of the various operations undertaken to determine the figure of the earth, dating from Airy's investigations of 1830 to Helmert's determination of 1906, proves incidentally the extraordinary value of the early investigations undertaken with inferior instruments. On Airy's figure the whole of the mapping of the United Kingdom still depends, nor have the results deduced from the reduction of the principal triangulation affected the map values. In the length of 700 miles from Shanklin to the extreme north of the Shetlands Airy's figure gives about four seconds in latitude too much, if we accept Helmert's figure as the criterion. This does not affect the linear accuracy of the map. Three figures were computed by Colonel Clarke (in 1858, 1866, and 1880 respectively) from the data furnished by the reduction of the principal triangulation. They are all in use, either in Africa or America. The mean value in length determined by Clarke of the semi-axis major of the ellipse, the revolution of which about its minor axis produces the spheroid of the earth's surface, is less than that of Airy and only slightly greater than that of Helmert. Colonel Close records his opinion that the probable value is somewhat greater than Clarke's mean.

Many people must have noticed the apparently haphazard way of recording "bench" marks by the Ordnance Survey to indicate altitudes determined by levelling. They are to be found on most unsubstantial walls, on milestones, and even on gateposts, and they must, many of them, inevitably be unstable. In the section of the pamphlet dealing with levelling, Colonel Close indicates the method by which, in future, such marks will be rendered permanent. Concrete blocks will be sunk on to hard rock foundations at intervals of about twenty-five miles all over the country; a bolt of bronze, with a knob of flint being embedded in the concrete. This section is also of interest as a record of the difficulties experienced in dealing with the adopted datum of mean sea-level. Indian survey investigations have contributed largely to the solution of this troublesome problem. It is in India, too, under Colonel Sir S. Burrard, that the most comprehensive investigations have been made in the matter of the deflection of the level, and the apparent eccentricities of the force of gravity, including the difficult problems which beset the speculative subject of isostasy; but Colonel Close's references to early English methods of determining the value of deflection due to local topography are extremely interesting as a record of the first steps taken in the evolution of this special branch of geodetic science. These plain and intelligible notes on a highly complicated subject, being entirely free from any affectation of technical specialism, should attract a much wider range of scientific interest than is indicated by the title of Ordnance Survey Professional Papers. T. H. HOLDICH.

SCIENTIFIC FACTORS OF INDUSTRIAL SUCCESS.

THE Institute of Industry and Commerce (now the Institute of Industry and Science), so the introductory leaflet states, is a counterpart of a German organisation known as the *Hansa Bund.* How the Hansa Bund arose or by whom and when it originated we have no knowledge. It is a confederation of important German firms for promoting, encouraging, and facilitating German home and foreign trade. It is proposed by similar means, but on somewhat "superior lines," to do the same for British industry, and the directors invite those interested in the development of our industries by the aid of science to enrol themselves as members. A portion of the revenue of each year is to be devoted to scientific research under the supervision of our most eminent men of science. Accompanying this leaflet are a number of brochures touching on the causes and effects of German commercial success and on the remedies for British commercial decline.

If "in the multitude of counsellors there is safety," in the diversity of their opinions there may also arise confusion. Sir W. Ramsay conceives that the main purpose of the Institute is to combat German industrial methods, which are said to be organised on a policy of dishonesty and trickery. This is to be undertaken by the State by adopting something of their methods, or by endeavouring to thwart them. Mr. S. Roy Illingworth, in his pamphet on "The Organisation of the Chemical Industries," advocates combination between different branches of industry, elimination of home competition, efficient advertising, the employment of highly trained chemists and engineers, reducing the cost of production, and finally some measure of protection. Sir George Watson, who also writes on "Chemistry and Industry," lays stress on the importance of highly trained chemists and the value of protection or some form of financial assistance for the newer industries. Mr. J. Taylor Peddie, in his review of "British Imperialism and German Culture," points out that although German ideals have been established upon sound democratic and Christian principles, and have had a vital, sustaining, and elevating influence, these ideals have been momentarily wrecked on the rocks of feudalism, absolute monarchism, and militarism. He realises Germany's intellectual superiority, for which we have no substitute, and demands organisation unrestricted by the State, which is too much dominated by the political party system. In a second brochure on "Finance and Industry" the same writer finds Germany's great commercial progress to be primarily due to the development of its financial system, and instances the advantages which the banks offer by advancing loans to industrial undertakings.

It will be seen from this rather brief epitome that whilst the writers unite in pointing out the unsatisfactory position of our industries, especially those into which science largely enters, they are not quite unanimous, either in regard to the cause of or the remedy for the present state of affairs.

It is no doubt true that our chemical industries have in the past been hampered by absurd duties and still more absurd patent laws, and that, speaking generally, the scientific industries have received little sympathy or encouragement from any Government, past or present. It is also true that German commercial acumen, not always over scrupulous, has succeeded in wresting from us a good deal of foreign trade. In this connection we are reminded of a chapter in Bagot's "My Italian Year," in which he describes how Germans have established themselves, as well as their goods, in the larger Italian cities, and that much of the trade formerly carried on by us has passed into their hands. All this is true enough, but there is another side to the picture. Our chemical industries have failed to prosper not because Germany has had special advantages in the use of cheap alcohol, or in its patent laws, or in its financial system or in its protective tariff, but because in recent years these industries have passed into the hands of men who have had no proper chemical training.

So long as this exists the industry will be run by rule-of-thumb methods; no advance can be made, because nothing new is being discovered or manufactured; for it must be remembered that it is not the old stereotyped products, but the novelties that bring the large profits. Where can we show such a record as that of the Baden Aniline Company, which laid out a million sterling on experiments carried out by a body of highly trained and *highly paid* chemists working unceasingly for ten years in elaborating the process for producing artificial indigo, which has now nearly driven out the natural product?

We lack knowledge first and last, as well as enterprise and that kind of adaptability which studies to supply the needs of foreign countries, and this applies to others besides the chemical trade. We remember an old Lancashire cotton weaver, whose trade, once a thriving one, gradually fell away because he insisted on always producing the same kind of cloth long after it had ceased to be in demand, for no other reason than that he had always done so.

We could point to many other industries which to-day are languishing or disappearing for the same reason. The heads of these firms do not keep pace with the time; they do not keep up any pace at all; they stand still. They stagnate in a backwater of ignorance, unconscious of the rapidly flowing stream of scientific achievement; which must in the future be the guiding current in every branch of industry if commercial success is to be attained.

It was announced on Monday that there has been such a poor response on the part of subscribers that the directors of the company British Dyes (Limited) do not feel justified in proceeding to allotment, and a meeting has been called to consider the situation. This state of affairs might have been anticipated from the amount of adverse criticism to which the Government scheme has been subjected. The scheme restricted competition at home, but made no attempt to safeguard future competition from abroad, and gave no guarantee in the constitution of the directorate that the industry would be conducted on a sound scientific basis. The question is still unanswered as to the best and safest means of resuscitating this moribund industry (if one may apply these terms to describe what has never been really alive for the last half-century).

Every chemist will admit that this is a problem which cannot be solved in a hurry. Owing to the complex nature of the products and the special character of the apparatus and machinery employed, a long period of patient experimenting under the control of the best chemists and chemical engineers that the country can provide will be required before success can be attained. It will naturally entail a heavy outlay in salaries and plant, and probably no profits for a long time to come. Who is going to undertake this whilst the textile industry with its millions of workpeople is starved for the want of dyes? If the country ran short of ammunition in the present crisis, the Government would at any cost be compelled to undertake its production.

The same kind of national crisis exists to-day in the dyeing industry, and the same remedy should be applied without further delay. The colour-makers have had their opportunity. They have been warned for years past what their fate would ultimately be if they neglected to develop their manufacture on a scientific basis. That opportunity has gone. The only practical plan would seem to be for the Government to take the matter in hand and independently of public financial assistance to obtain its staff of expert chemists under adequate scientific control, and by their aid to work out the initial experimental stages and afterwards either manufacture the dyes or make over the processes on certain conditions to private firms.

NOTES.

WE regret to see the announcement of the death, on March 21, in his sixty-fourth year, of Dr. A. A. W. Hubrecht, professor of embryology at the University of Utrecht.

THE honorary freedom of the Apothecaries' Company has been conferred upon Sir Ronald Ross, in recognition of the valuable services rendered by him to medical science, especially in the prevention of tropical disease.

IN recognition of their services as consulting surgeons to the British Expeditionary Force in France Mr. G. H. Makins and Sir Anthony A. Bowlby have been made Knights Commander of the Order of St. Michael and St. George (K.C.M.G.).

THE *Nieuwe Courant*, the Hague, of March 3, states that the van't Hoff fund committee of the Academy of Sciences of Amsterdam received five applications for grants. The only one awarded was for 600 francs to Dr. E. D. Tsakalotos, of Athens, in aid of his researches on the thermal properties, the viscosity, and the magnetic susceptibility of binary mixtures, capable of yielding endothermic compounds.

AT a meeting of the executive committee of the British Science Guild, held on March 16, it was resolved to send copies of a resolution formulated by the medical committee, advocating inoculation against typhoid fever, to the commanding officers of every regiment of the British Army. Reports on the question of the supply of optical glass and of glass for chemical purposes—formerly largely obtained from Germany and Austria—showing what has already been done in these matters, were also ordered to be widely circulated. The question of the shortage of microscopes was considered, and action is being taken by the guild in this matter.

THE death is announced, after a short illness, of Prof. W. Smart, professor of political economy at Glasgow University. Prof. Smart began his academic work in 1886 as lecturer on economics at University College, Dundee, and Queen Margaret College, Glasgow. On the affiliation of Queen Margaret College to the University, he became University lecturer on economics, and in 1896 was appointed to the Adam Smith chair of political economy. In addition to his professorial work, Prof. Smart translated Böhm-Bawerk's "Capital and Interest" and "Positive Theory of Capital," edited Wieser's "Natural Value," and compiled "Economic Annals of the Nineteenth Century." Among his other works are "Taxation of Land Values" and "The Return to Protection."

THE Geologists' Association has made arrangements for an excursion to Glasgow from April 2 to April 8. The object of the excursion is to examine the geology of the district around Glasgow. On April 2 Prof. J. W. Gregory will conduct the party around the Campsie Fells. On April 3 South Bute will be visited under the directorship of Mr. W. R. Smellie. Garabal Hill, Loch Long, and Loch Lomond will be studied on April 5 under the guidance of Mr. A. Scott; the Falls of Clyde, Cartland Gorge, and Kames of Carstairs on April 6, when Prof. J. W. Gregory and Mr. J. Stark will direct; Lugar and Mauchline on April 7, director, Mr. G. W. Tyrrell; Hamilton Park and Strathaven on April 8, directors, Messrs. Macintyre and Carruthers. Intending visitors should communicate with the secretary for the excursion, Miss G. M. Bauer, 16 Selborne Road, Handsworth Wood, Birmingham, from whom particulars as to trains and accommodation can be obtained.

THE death has occurred at Dartmouth, at the age of eighty-six, of Mr. E. W. H. Holdsworth, who will be remembered by his book, "Deep-Sea Fishing and Fishing Boats," published in 1874, which gives the best and most intelligent account of the British fisheries at that time which we possess. This book will always be of the first importance to those interested in the progress and development of our sea fisheries. Mr. Holdsworth wrote from great personal knowledge of the subject, as he had acted as secretary to the Royal Commission, of which Prof. Huxley was a member, which between 1863 and 1865 travelled all around the British coasts inquiring into the condition of the fisheries. At the close of the work of this Royal Commission, Mr. Holdsworth went for some years to Ceylon in order to conduct an official inquiry into the pearl fisheries. In 1883 Mr. Holdsworth took an active part in the International Fisheries Exhibition and contributed to the literature of that exhibition an important paper on apparatus for fishing. On the foundation of the Marine Biological Association he was for some years a member of the council. Previous to his work in connection with the fisheries Mr. Holdsworth took part in the management of the Zoological Gardens, Regent's Park, and the Proceedings of the Zoological Society contain several papers which he wrote, chiefly on anemones and corals.

MR. J. S. MACARTHUR, whose name is well known in connection with the cyanide process of extracting gold, has been engaged during the past two years in the extraction of radium from carnotite and similar ores at his factory at Runcorn. From a statement in the Press we learn that Dalvait, Loch Lomondside, has been selected as the site for a new factory, on account of the advantages offered by the purer air and water supply in this neighbourhood. The new factory is to deal with between five and six grams of radium annually, and will be a welcome addition to the country's sources of radio-active materials. Hitherto, with the exception of one concern, working up the pitchblende from the Trenwith mine, Cornwall, this country has been entirely dependent upon foreign radium. The output of another Cornish pitchblende mine is sent to France to be extracted, and the recently discovered source of pitchblende of very fine quality in India, seems, like the Indian monazite, to be controlled by foreign capitalists. The Glasgow and West of Scotland Radium Committee purchased from Mr. MacArthur last year the equivalent of 600 milligrams of radium bromide in the form of a barium-radium carbonate containing 20 milligrams of radium bromide per kilogram, finding it more advantageous to undertake itself the further fractionation of this material than to purchase from abroad at the inflated prices then obtaining.

IN the scientific world probably the highest distinction is the election of a man of science to foreign membership of the leading scientific society of a country not his own. Prof. E. C. Pickering has from time to time published lists of men of science who have received this honour from two or more of the seven great scientific societies, viz., the Imperial Academy of Petrograd, the U.S. National Academy, the Royal Prussian Academy, the Royal Academy of Sciences in Vienna, the Royal Society, the Institute of France, and the Royal Academy of the Lincei. The first such list was published in 1908, and since then more than a third of the men whose names were included have died. Prof. Pickering, in an article in the February number of the *Popular Science Monthly*, has brought the list up to the beginning of 1914, and analysed it according to societies, countries, and sciences. The men of science whose names appear in the list number 122, sixteen of whom are members of all seven societies, and fourteen of six societies. Four men of science in Prussia, namely, A. Auwers (since deceased), E. Fischer, van't Hoff, and R. Koch, and three Englishmen, namely, Sir A. Geikie, Sir William Ramsay, and Lord Rayleigh, are members of all seven societies. Taking two groups together, England leads with eight men of science who have achieved the distinction of election to foreign membership of six or seven national scientific societies, and is followed by Prussia, which possesses six such men. The average number of scientific societies for English members is 4·9, for Prussian members 4·2, and for Germany as a whole, 4·0. As regards the different branches of science, "In mathematics, the country most largely represented is France, with 5 members; in astronomy, United States, 5, England, 4; in physics, England, 5; in biology, Prussia, 5. Great Britain is the only country represented in each of the sciences. Prussia has no geologist, France no geographer, and the United States no mathematician, chemist, botanist, or biologist."

THE jubilee of the University of Melbourne Medical School was celebrated on April 25–May 2, 1914, and a memorial volume containing the history of the school and the jubilee addresses, and embellished with numerous plates of the buildings and laboratories and members of the staff, has been issued ("University of Melbourne Medical School Jubilee, 1914," Ford and Son, Melbourne). The University of Melbourne had been in existence for seven years when its medical school was opened on March 3, 1862. The school owed its inception largely to the energy of Dr. Anthony Colling Brownless, who became Vice-Chancellor of the University in 1858. In 1862 Dr. John Macadam was appointed lecturer on chemistry, Dr. G. B. Halford professor of anatomy, and Mr. R. Eades lecturer in Materia Medica. In 1863, the medical school buildings were commenced from plans prepared by Messrs. Reed and Barnes, the University architects. In 1864, the Melbourne Hospital opened its doors to receive the first class of third-year students, Messrs. Rees, Moloney, and Mackie. Although its career has been checked from time to time by lack of funds, the story of the school is one of continued progress. Opening in 1862 with four students, the students' roll now (1914) numbers 394 for the five years of the curriculum. The latest development is the establishment of a fund for clinical research, which now amounts to approximately 1000*l.* per annum.

THE forty-eighth report of the Peabody Museum at Harvard University is a record of active progress. Additions to the buildings now provide much needed accommodation for the collections. Exploration has been active in various regions—Mexico, Nebraska, New Jersey, Arizona, Syria, Palestine, and Egypt. Dr. E. A. Hooton conducted an expedition to England. Landing in July last, he worked for a month, when "he was forced to discontinue work because of the unsettled state of the country." He excavated without much success the alleged site of an early Saxon cemetery at Great Shefford, Berks, and then he turned his attention to Wexcombe Down, overlooking Salisbury Plain, where nine barrows were opened containing incinerated remains, Bronze Age potsherds, and surface finds of late Celtic and Roman pottery. One large cinerary urn and one La Tène III. bronze fibula were found. From Knowle Pit, Savernake, a series of River-drift implements was obtained.

CAPTAIN SIR G. D. DUNBAR in the February 26 issue of the Journal of the Royal Society of Arts describes some of the tribes occupying the northern frontier of Assam. Owing to the inaccessibility of the country and the savagery of its inhabitants, little is known about them. The tribes here dealt with are the Abors, Daflas, and Mishmis. The word Abor means "unfriendly," which well describes the character of the group. The general type is Mongoloid, and the writer suggests that the Abors and their brethren migrated from the Tibetan side of the Himalayas into the Dihang valley. They display remarkable industrial capacity in their bridges, irrigation channels, and ironwork. It is not possible to imagine a more democratic organisation than the constitution of these tribes. The village, not the clan, is the political unit, ruled by a headman, whose office is not hereditary, but he is retained in office only so long as he represents the views of the majority in their rather noisy meetings. Women exercise a marked influence. Other duties now prevent Sir G. D. Dunbar from preparing a book on these tribes, but it may be hoped that this intention is only for a time postponed.

IN the *American Museum Journal* for February Col. Theodore Roosevelt contributes an admirable article on the animals of Central Brazil, and Mr. L. E. Miller gives an account of the Roosevelt-Rondon

Scientific Expedition. The value of this exploration will be shown only when full studies have been made of the 2500 and more specimens of birds and mammals which have been collected. This will for the first time provide an outline of the mammalogy and ornithology of this hitherto unknown region, which includes a river as long as the Rhine, of which there appears to be no trace on the existing maps. Of special interest is the account of the man-eating fish, the piranha. "South America," Col. Roosevelt remarks, "makes up for its lack relatively to Africa and India of large man-eating Carnivora by the extraordinary ferocity or blood-thirstiness of certain small creatures of which the kinsfolk elsewhere are harmless. It is only here that fish no bigger than trout kill swimmers, and bats the size of the ordinary flittermouse of the northern hemisphere drink the blood of big beasts and of man himself."

In the Journal of the Straits Branch of the Royal Asiatic Society for December, 1914, Mr. J. C. Moulton, curator of the Sarawak Museum, continues his list of the butterflies of Borneo, dealing in this instance with the whites and swallow-tails, or Papilionidæ. No fewer than forty-three species, together with a number of subspecies of the true swallow-tails of the genus Papilio, are recognised, against twenty-nine in a list published by Dr. Russel Wallace in 1865.

To the March number of the *Irish Naturalist* Dr. R. F. Scharff contributes a tentative list of the native names of Irish mammals. There is a considerable degree of uncertainty with regard to the proper application of some of these names, and in a few instances, which may represent species now extinct, identification has not yet been practicable. Several names for the bear and the wolf are known, and it is possible that one or more of the unidentified terms may refer to the extinct giant Irish deer or "elk."

A striking coloured plate of the king-condor of the Andes forms the frontispiece to an article in the April number of *My Children's Magazine* on the vertical distribution of animal life on land and in the ocean. Most of the more striking instances of animals dwelling at great heights in the mountain-ranges of the world are mentioned, and the article as a whole is a mine of information. The artist cannot, however, be congratulated on his rendering of the red deer's antlers or on his so-called wild sheep and yak, which are obviously drawn from domesticated breeds.

In Mr. T. Southwell's report of the Bengal, Bihar, and Orissa Fishery Department for the year ending June 30, 1914, attention is directed to the extent of the area under the control of the Department, the smallness of the staff, and the difficulties encountered, in endeavours to improve the present condition of affairs owing to the indifference and lack of energy on the part of the fishermen. It is admitted that in Bengal the supply of food-fish, always short, is steadily falling, but since the occupation of fishing or dealing in fish is carried on exclusively by the lower classes the whole industry is left in the hands of people with no capital, no education, and no business capacity. In such circumstances it is scarcely to be wondered at that the fish-supply is scanty. In area and potentiality the fresh-water fisheries of Bengal are second to none; but the establishment of hatcheries for carp and other species of fish is highly desirable in order to mitigate the disaster to eggs and fry occurring annually in the big rivers during the rains. The rearing of eggs and fry removed from the mouth of the Damodar and their return to the river as young fish at an age when they are able to look after themselves, seems to be a step in the right direction, and one which should eventually give satisfactory results. As time and opportunity allow, the stocking of other small rivers will be carried on, where the necessity is indicated. The rearing of fry in special tanks will further enable small fish to be supplied for tank-culture throughout the province, at an age when they are unlikely to be devoured by voracious fish, whereby considerable improvement in tank-culture generally may be expected.

Among specimens received by the U.S. Museum from the Lower Eocene of Fort Union, Montana, particular interest attaches to the left half of the lower jaw of a small mammal described by Dr. J. W. Gidley in No. 2077 of the Proc. U.S. Nat. Mus. (vol. xlviii., pp. 395-402) as a new genus and species under the name of *Myrmecoboides montanensis*. The specimen, which retains the canine and seven cheek-teeth, is regarded by its describer as indicating a marsupial, which may be related to the Australian banded anteater (*Myrmecobius fasciatus*). The dentition presents the distinctly marsupial feature that all the last four cheek-teeth are molariform, and of the same general type, the first of the series being, however, slightly more complex than the other three. In many respects all the teeth present resemblances to those of Myrmecobius, although those with a molariform structure are relatively larger, and not separated from one another by intervals. If, however, the dentition of Myrmecobius be of a degenerate type, as is now generally believed, such differences are precisely those which would be expected in an ancestral form. What an important bearing such a relationship would have on the origin and dispersal of marsupials will be obvious. In addition to this, the Fort Union fossil may serve to solve a disputed point in regard to marsupial dentition. For, as Dr. Gidley points out, the first molariform tooth presents several features suggestive of its being a persistent milk-molar rather than a molar; and if this idea be well founded, there will be decisive evidence in favour of the view first suggested by Dr. Winge, and also arrived at independently by Mr. Lydekker in 1899, that the first molariform tooth of marsupials is a persistent milk-molar, and not, as previously supposed, a molar, and consequently that both placentals and marsupials normally possess but three pairs of molars.

We note with interest that the Lincolnshire Naturalists' Union is taking steps to preserve the ancient flora of Lincolnshire from extinction. Owing to cultivation, drainage of bogs, eating off by sheep, and the rapacity of trippers much has been lost. By educating the populace to respect the flora and by jealously guarding the habitats of the rarer plants, the Naturalists' Union should do useful work.

The *Indian Forester* for January, vol. xli., No. 1, contains a short account of the tali-pot palm (*Corypha umbraculifera*), which is indigenous in the Andamans and Southern India. Its uses are many; the pith is used for flour, some thirty headloads being yielded by one tree. The leaves, which were formerly used for writing upon, now serve for umbrellas and thatching, and the seeds are carved or made into buttons. At Honawar bats live under the protection of the leaves of the tali. When the lendi fruit (*Calophyllum inophyllum*) is ripe, the bats bring back large quantities to their palm and drop the hard drupes. As these contain oil, which is much prized, the bats serve a useful purpose, and natives are planting the tali-pot palm in order to obtain oil in this easy manner.

In an article reprinted from the *Botanical Gazette*, vol. lviii., No. 3, Dr. G. D. Fuller breaks new ground in plant ecology and presents results which, as in the case of much recent work in this subject, is of great interest to agriculturists and foresters as well as to botanists. He has made a detailed series of determinations at weekly intervals during the growing period (May to October) of the rate of evaporation and the amount of soil moisture in a series of plant communities which shows a gradual change or succession from exposed sand vegetation to moist beech-maple forest on the sand dunes near Chicago. The determinations, extending over three years, are presented in graphs; those of evaporation were taken with evaporimeters placed near the ground, those of soil moisture in the upper layers of the soil—in both cases the critical regions, since within them develop the seedlings which determine the character of the succeeding vegetation. The author introduces the term "growth-water" for the percentage of soil moisture in excess of that found by experiment to be present in the soil when wilting occurs in plants; and he finds that the differences in the ratio between evaporation and growth-water in the series of plant communities investigated are sufficient to be regarded as efficient factors in bringing about the succession or gradual change from the scanty drought-enduring (xerophytic) vegetation of the open sand to the moisture-loving (mesophytic) broad-leaved forest, which forms the climax of the series.

In vol. xiv., part 1, of the Annals of the South African Museum Mr. George Arnold, of the Rhodesia Museum, Bulawayo, commences an illustrated monograph of the ants of South Africa, which it is claimed will form the first collective account of the (approximately) three hundred known local species. Vol. xv., part 1, of the same is devoted to a continuation (part 7) of the Rev. T. R. R. Stebbing's account of South African Crustacea. Six species and two genera of Macrura are named as new, and certain emendations in pre-existing nomenclature suggested.

The association of geology, botany, and zoology in the domain of a State Survey is interestingly exemplified in the sixth biennial report of the Commissioners of the State Geological and Natural History Survey of Connecticut. The superintendent, Prof. W. N. Rice, points out the desirability of the maintenance of the survey as a permanent bureau of publication. Much of the work is done by men who are otherwise engaged for a large part of the year, and the annual appropriation of 1500 dollars may be considered modest for a State where a high level of general culture is ready to respond to scientific information.

The potash salts associated with the Cambrian rock-salt of the Cis-Indus Salt Range have been known since 1873; but a more complete examination of their extent has now been made by Dr. W. A. K. Christie (Records Geol. Survey of India, vol. xliv., 1914, p. 241). This author concludes, on account of the association of kieserite, sylvine, langbeinite, and rock-salt, that crystallisation finally took place under subterranean conditions at a temperature of about 80° C. It is interesting to note that the very soluble potash-salts have been preserved where a fine clay with sand-grains, probably wind-borne, was formed across the deposits of the evaporating lagoon.

An interesting rock is described by Dr. du Toit from the slope of Ingeli, in the extreme south-west of Natal (Geological Survey of South Africa, Annual Report for 1913, p. 99). In a stratum about 15 ft. thick, pellets of graphite, which may be as much as an inch in length, lie in a ground of oligoclase, quartz, cordierite, enstatite, and biotite; this ground has in part a micropegmatitic structure. This unique rock is ascribed to the partial absorption of a carbonaceous shale of the Ecca Series by an offshoot from the overlying intrusive sheet of norite. Kentallenite, the curious biotite-olivine-dolerite with soda-orthoclase, well known from its occurrence in Appin, is now recorded by Mr. S. Kôzu from Torigoé, Japan (Science Rep., Tôhoku University, Sendai, Japan, vol. ii., 1914, p. 1).

The South Wales tornado of October 27, 1913, which involved some loss of life, has been discussed by the Meteorological Office in No. 11 of its Geophysical Memoirs (price 6*d*.). Dr. Shaw states that a scientific assistant attached to the office, Mr. H. Billett, was sent to the neighbourhood to collect information on the spot. A severe thunderstorm swept the west of England and Wales from the south of Devon to Cheshire, and developed locally into a tornado of exceptional violence. The storm was intense for a distance of about 11 miles up the Taff Valley in Glamorganshire, for about an equal distance in Shropshire, and for about 5 miles in Cheshire. For several days before and after the occurrence, a high-pressure system was situated over Central Europe, and there was a low barometer centred over the Atlantic. The wind over the region affected was mainly from south-east or south, with the temperature decidedly above the average, and the weather unsettled. The rainfall was almost wholly limited to the south-western and western districts of England. Practically no damage was done outside the narrow limits of the storm, which nowhere exceeded 1000 ft. in width, but much destruction was wrought in certain parts of the track. In Cheshire, where the storm's track was about 450 ft. wide, the sound is described as that of "hundreds of motor-cars crashing through the trees." The storm occurred at about 4 p.m. in Devon, at 5.40 to 5.50 p.m. in South Wales, at 7.35 to 7.45 p.m. in Shropshire, and at 9 p.m. in Cheshire. The progress of the central area of the storm is given as 36 miles an hour No absolute measurement of wind velocity was secured, and a similar absence of barometer records is mentioned, with the exception of one station only a few yards from the South Wales track, where the record shows a fall of pressure from 29·20 in. to 28·91 in., followed by an almost immediate rise.

THE *Scientific American* for February 13 contains the third of the series of articles entitled "Doing without Europe," to which we referred in these columns a month ago. The principal object of the articles is to show how vast are the mineral resources of the country and how little they are utilised. The present article deals mainly with the barium salts used in the manufacture of paint. Up to the commencement of the present war these had been imported from Germany, but one of the largest paint manufacturers of New York has commenced manufacturing them from an ore found in Tennessee, and now turns out 15 tons a day. In respect to potash salts, of which the annual import from Germany exceeded 3,000,000*l*., the United States Government has directed attention to the natural deposit of the salts at Searles Lake, California, and a manufacturing plant has been set up there the success or failure of which will be watched with interest. Soda, magnesia, and several other substances are also mentioned as being found in abundance in the country, and as only requiring working to supply all requirements.

AN interesting paper on the internal-combustion engine in the oil field was read at the Institution of Petroleum Technologists on March 18 by Mr. F. G. Rappoport. It appears that the steam engine still largely holds its own despite its inefficiency, the reason for this being in the special character of the work to be done in boring and baling oil wells. Great flexibility in power and speed is required, and while electric power distributed from central stations is ideal from other points of view, electricity lacks that flexibility at the well which makes steam power so convenient. The oil engine has created a large and important sphere of its own by facilitating profitable operation of a large class of wells having a small yield. Such wells had formerly to be closed, and the advent of the oil engine with its low fuel-consumption has rendered possible their operation. The oil engine is well adapted for outlying districts and for prospecting work; the Binagadi oil field, without adequate water supply, is worked almost entirely by means of oil engines. The new Ural and Biellik districts in Russia are largely worked by oil engines. Applications of the gas engine are also discussed, and reference is made to an engine made by Messrs. Tangye, which can be run as a gas engine, or as an oil engine, by alteration of certain parts. Several of these engines are in successful operation on the Baku oil field.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have just issued a classified catalogue of numerous scientific books, periodicals, and publications of scientific societies which they offer for sale, including large selections from the libraries of the late Sir Robert Ball and Dr. J. Reynolds Green. The catalogue contains titles and descriptions of many rare and valuable works which may be purchased at reasonable prices for private or public libraries.

OUR ASTRONOMICAL COLUMN.

COMET NOTES.—In the *Astronomische Nachrichten* (No. 4789) Dr. Elis Strömgren communicates an ephemeris up to March 29 for comet Mellish (1915*a*), computed by Herren J. Braae and J. Fisher-Petersen, from the parabolic elements given by the latter, with Herr R. Andersen. The data for the present week are as follows:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
March 25	17 55 53	−0 34·9	8·8
27	17 58 13	0 50·0	
29	18 0 33	1 6·1	8·6
31	18 2 51	1 23·1	
April 2	18 5 9	−1 41·2	8·5

The comet lies approximately between γ Ophiuchi and η Serpentis.

Herr K. Hillebrand, in an Ephemeris Circular of the *Astronomische Nachrichten* (No. 478), publishes the elements and ephemeris of the periodic comet of Winnecke for its appearance in the current year. The latter extends from April 16 to the end of August.

A search ephemeris for Tempel's comet (Ephemeris Circular, No. 479) is given by Herr J. Braae. In 1910 this comet was not seen, but it is pointed out that this year it will be a little more favourable for observation. The ephemeris is extended to the end of June of the present year, and will be continued later.

THE STRUCTURE OF THE Hγ LINE IN STELLAR SPECTRA. —In this column for July 31 of last year attention was directed to a paper by Herr K. F. Bottlinger, in which was shown the result of a study of the intensity distribution of lines in many of the brighter stars. In a recent number of the *Astronomische Nachrichten* (No. 4788, vol. cc., No. 12) Dr. Adolf Hnatek gives his conclusions from rather a similar investigation. The author has measured both the intensity (Linientiefe) and breadth (Linienbreite) of the Hγ line in several bright stars, and summarises the values deduced according to the spectral types of the stars examined. Thus, in the case of the line-width the following are mean values in Ångström units which he has deduced.

Maury	Cannon	Width	Intensity
II–VI	B	16	0·55
VII–VIII	A	26	1·40
X–XI	F	17	0·81
XIII–XV	G–K	8	0·35

Summarising the values of the line-intensity (Linientiefe), he points out that they show also a similar relation to the spectral types; these intensity values are added in the last column of the above table. The paper contains also a number of curves of the Hγ lines in the individual stars arranged in groups according to their spectral classes. While the above investigation deals only with one line and a small number of stars, the author hopes to extend the research to more lines and stars in order to deduce results of a more definite and trustworthy value.

The Harvard College Observatory Report.—The annual report of the director of the Astronomical Observatory of Harvard College for the year ending September 30, 1914, indicates the completion of a large amount of work in both observation and publication. Prof. E. C. Pickering refers in the first place to the principal work of the observatory, namely, its publications and the importance of issuing these as soon as possible to prevent loss by fire. Thus observations from 1892–1912 with the 15-in. equatorial, from 1888–98 with the 8-in. transit circle, and from 1898–1912 with the 12-in. meridian photometer are now printed, and the discussions are in progress. The director directs attention to the improvement in photographic processes resulting in the replacement of practically all visual work. The report then describes in more detail the work of the Henry Draper Memorial, the principal research of which is the New Draper Catalogue; last year Miss Cannon classified 60,386 spectra, making a total of 160,541. The activities of the Boyden department, the Bruce photographic telescope, and the Blue Hill Meteorology Observatory are briefly summarised, while among the many items mentioned under the heading "Miscellaneous" the work of Prof. W. H. Pickering at the Mandeville Station, in Jamaica, is described, much time having been devoted to the study of the planet Mars during its recent opposition.

Star Charts for Meteor Observers.—One of the contributions to the January number of the Journal of the Royal Astronomical Society of Canada (vol. ix., No. 1, p. 7) is entitled "A Gnomonic Star Atlas," and contains a set of thirteen maps, prepared by Mr. Reynold K. Young, intended to facilitate the observation of meteors and the plotting of their paths. The method of the projection of the map is such that great circles in the sky are equivalent to straight lines on the map, thus making the plotting of the meteor trails more easy. The maps are devoid of unnecessary detail. The positions of the stars are given for the epoch 1900 correct to within one-tenth of a degree, and all stars down to 5th magnitude and the brighter variables are included. A good margin of overlap has been allowed in each map, which should prove very useful.

FLUCTUATIONS OF TEMPERATURE IN EUROPE AND AMERICA.

Mr. H. ARCTOWSKI, in a paper published in vol. xxiv. of the Annals of the New York Academy of Sciences, considers the problem of variation of temperature over the whole earth. After a brief statement of the general problem and the methods by which it may be attacked, he explains that he could not deal single-handed with the arrangement and discussion of the actual values even over the whole of the northern hemisphere, and confines himself to the detailed survey of the variations over North America and Europe. He also compares the results with one or two representative equatorial and southern hemisphere stations. From a study of the values at one of these, Arequipa, in Peru, he deduces that the temperature changes are partly of a short period of about fifty-five days, brachypleionian waves; partly of a long period of twenty years or so, macropleionian waves; and partly of an intermediate period of between one and two years, pleionian waves.

In dealing with the longer periods the normal annual variation is eliminated by taking a series of means for twelve months beginning with each consecutive month of time. For the European stations he finds that the continental ones resemble Arequipa in having marked pleionian waves, while those stations near the Atlantic are characterised mainly by brachypleionian variations.

In an earlier paper Mr. Arctowski dealt with the period 1891–1900, and he takes the mean values for this period as normals, and plots on maps the difference from normal of the values during each year of the decade 1900–09. The areas where the differences are positive he calls thermopleions, and the areas of negative differences antipleions. He finds that certain years, in particular 1900, 1908, are characterised by thermopleionian areas, while others, such as 1904, 1907, are years of antipleions. The most important cause of these differences is the variation of solar radiation, but there are also supplementary causes such as the presence of volcanic dust in large quantities, or exceptional ice conditions in the polar regions.

Many of the maps which illustrate the results of the investigation are on a very small scale; the course of the thermopleions and thermomeions is obscured by the attempt to show relatively microscopical geographical details.

Mr. Arctowski finds it astonishing that after all the efforts which are made to organise and maintain meteorological stations all over the world, the actual results of the work are so inaccessible. Even for the area with which he dealt he could only get much of the data by writing personally to the directors of the different meteorological institutes. This is a defect which will be remedied when meteorologists of different countries undertake to contribute to a central bureau representative regional values based on a selection of stations which can only be chosen satisfactorily by the local organisation.

There is another defect which is almost more serious, viz., the lack of continuity in the records for individual stations due to changes of situation or instruments. For example, Mr. Arctowski finds that the difference of temperature between Chicago and Milwaukee was nearly 4° F. in the decade 1873–82, while in the decade 1896–1909 the difference was only 2° F. The change is almost certainly due to change of instrument or site, and as it is of the same order of magnitude as the changes with which he deals, it indicates the need for great caution.

The difficulty of securing comparable continuous records is indeed one of the most serious problems with which organised meteorology has to deal.

E. G.

REFINING GOLD BY ELECTROLYSIS.[1]

THE problem presented by the necessity of refining gold was one for which a solution was sought at least as early as the time, about B.C. 700, when coins were first manufactured in the Western world. Apart from toughening or the removal of base metals, which was sufficiently cared for by the ancient process of cupellation, it is clear that some measure of success attended the efforts made to part gold and silver. Thus, some of the ancient Greek coins containing 997 or 998 per 1000 of gold. The earliest parting process used was one of cementation, which was succeeded by the nitric acid process. At the present day chlorine is the predominant agent for parting gold from silver in Australia, electrolysis in America, and sulphuric acid in Europe.

The electrolytic process was brought forward by Charles Watt, at Sydney, in 1863, and was first put into operation by Wohlwill at Hamburg in 1878 and by Tuttle at the Philadelphia Mint in 1902. In the gold chloride process the solution used in the bath

[1] Abstract of the presidential address delivered before the Institution of Mining and Metallurgy on March 18, by Sir T. K. Rose.

contains gold in the form of chloride and some free hydrochloric acid. Gold is dissolved at the anode, under the action of a current of electricity, and deposited in a pure state at the kathode. Other metals are also converted into chlorides at the anode, and either remain in solution, or pass into the anode slime. When silver is contained in the anode, it is converted into silver chloride which in part dissolves, in part falls to the bottom of the cell, and in part adheres to the anode, forming an insoluble coating. The result of the coating is that the free area of the anode is reduced, the density of the current becomes greater per unit area of effective anode surface, and chlorine is evolved unless a very small current is used. According to general experience, if more than 6 per cent. of silver is present in the bullion of the anode it is necessary to brush the silver chloride from the anodes, and accordingly this percentage is seldom exceeded in practice.

Photo] FIG. 1.—Electrolytic gold cells, United States Assay Office, New York. [*B. P. Wirth.*

The usual amount of free hydrochloric acid present in the bath varies from 3 to 10 per cent., but according to the results of experiments now put forward by Sir Thomas Rose some advantages are obtained by the use of stronger solutions. Thus in a bath containing 29 per cent. of free hydrochloric acid, a current of 5000 amperes per square metre of anode surface can be used without causing chlorine to be evolved at the anode. Under these conditions the proportion of silver in the anode may be raised to at least 20 per cent. without difficulties being encountered. The heavy current causes the silver chloride to split off from the anode, and also prevents gold from entering the anode slime, principally because no monochloride of gold is allowed to form.

Similar advantages occur in the deposition of gold at the kathode by the use of a solution containing 20 per cent. of gold as chloride instead of the usual 3 to 5 per cent. With a current of 5000 amperes per square metre, the gold is deposited in a coherent form, which is easily washed, and is malleable after being melted. The density of current now employed in practice is below 1000 amperes per square metre, and the anodes occupy about a week in being dissolved. With a current of 5000 amperes, the anodes would be dissolved within the limits of a working day and a saving in interest, and in the difficulties of daily stocktaking, would be effected.

One of the merits of the electrolytic process is that the refined gold is always malleable and fit for use in the arts, and another is that any platinum contained in the gold is extracted. This is becoming of some importance in view of the high price of platinum and of the fact that nearly all rough gold bullion, including that from the Transvaal, is now known to contain that metal. According to the experience in the United States mints (Fig. 1), it is cheaper to refine gold by electrolysis than by sulphuric acid.

BIRD-MIGRATION IN 1913.[1]

WE have before us the ninth of a projected series of ten reports setting forth the imposing mass of data regarding bird-migration collected by the committee appointed for the purpose by the British Ornithologists' Club. Once the final volume, dealing with the autumn of 1913 and the spring of 1914, has appeared, we may expect a publication of greater importance, summarising the vast amount of material collected by ten years' labour. In the meantime no attempt is made to draw conclusions from the facts which are published, but a few points about the movements of 1912–13 may here be selected for notice.

The autumn of 1912 appears to have been remarkable for the early dates at which the migrations of several species began. Thus a swallow was noted at the Bell Rock Light in the Firth of Tay on July 4, and willow-warblers at the same place two days later. As early as June 25 a large flock of starlings had been seen flying west in the evening at Spurn Head Light. On the nights of July 14–15 and 15–16 swifts were recorded from the Lundy North Light (British Channel) and the Hanois Light (Channel Islands) respectively.

The great movements, however, do not seem to have begun until mid-October, and the migrations observed during the first three weeks of November were of extraordinary magnitude. Almost every night during that period half-a-dozen different light-stations record the passage of large numbers of birds, notably skylarks, starlings, and various species of Turdus.

[1] Report on the Immigrations of Summer Residents in the Spring of 1913; also Notes on the Migratory Movements and Records received from Lighthouses and Light-vessels during the Autumn of 1912. (Bulletin of the British Ornithologists' Club, vol. xxxiv., December, 1914.)

The winter which followed was marked by comparatively high and uniform temperatures. Consequently many summer-visitant birds do not seem to have quitted some of the southern and western districts, while others were recorded as returning at unusually early dates. The spring immigration proper is stated to have lasted from March 6 until June 6, reaching its height between April 14 and May 11.

Attention is directed to the very long period covered by the immigrations of certain species as contrasted with those of others. On one hand we have swallow (March 8 to May 20), sand-martin (March 13 to May 15), chiff-chaff (March 6 to May 8), and wheatear (March 12 to May 12). On the other we have the reed-warbler (April 18 to May 5), wood-warbler (April 9 to May 11), and nightingale (April 13 to May 5).

A special feature of the report is the long list of records emanating from the Caskets Light in the Channel Islands. This station is exceptionally favourably situated, and was expected to furnish very important data. Unhappily, the committee had formerly been unable to induce the light-keepers to take the matter up. The desired result has been brought about, however, by the transfer to the Caskets of an enthusiast in the work, Mr. R. E. Wilson. His contributions to the present report are very valuable. A special summary of the records relating to this station is promised for the next report.

The publication under discussion is even bulkier than its recent predecessors, but the data are set out in the same clear and orderly manner. As usual there are numerous charts and a useful summary of the meteorological conditions prevailing during the period covered by the migration records A. L. T.

THE INSTITUTE OF METALS.

IN spite of the war, both the number and quality of the papers presented at the annual meeting of the institute on March 18 and 19 were well up to the average. Naturally, in the circumstances, the contributions were furnished mainly by what may be termed the "academic" workers in non-ferrous metallurgy. Moreover, although the attendance of members was small, the discussions were always interesting and well-sustained. Unfortunately the president of the institute, Engineer Vice-Admiral Sir Henry Oram was prevented by his onerous official duties at Whitehall from presiding at the proceedings, and his place was filled at the last moment by one of the vice-presidents.

The paper by Prof. A. C. Huntington, on the effects of heat and of work on the mechanical properties of metals, gave rise to an interesting debate, and a spirited reply by the author. It describes a machine devised by him several years ago for the purpose of investigating these effects while the metals are being subjected to alternating bending stresses, such as occur in the firebox of a locomotive. No attempt was made to reproduce the somewhat complicated movements which occur there, but the metal or alloy was held rigidly at one end, and "subjected to a to and fro movement at the other end in a single plane at right angles to its axis." Both as regards the extent of the movement and the range of temperature investigated, the experiments were made to conform broadly to the kind of conditions that obtain in locomotive fireboxes. Various kinds of commercial copper, and a copper alloy containing upwards of 5 per cent. of nickel and iron, were tested in this way. The outstanding feature of the curves, the co-ordinates of which are temperature and the number of revolutions required to crack and break the specimens, is the large number of maxima and minima which the author interprets from his data. For copper he gives five maxima and five minima. The fact, however, that these do not by any means always correspond to observed points gave rise to considerable criticism in the discussion and to a variety of alternative interpretations. From the fact that annealing greatly reduces the maxima and minima the author concludes that work plays an important part in emphasising transformation points, and goes so far as to say that "except in the case of phase changes in alloys, mechanical tests are to be preferred to heating and cooling curves as a means of studying changes of state with temperature." Even if this claim is admitted, it limits the application of such methods to ductile alloys, but not unnaturally objections were voiced to a statement which has certainly not been proved.

Dr. Rosenhain, in his paper, entitled "Some Appliances for Metallographic Research," described an optical instrument for the levelling of metallographic specimens, a new method of taking thermal curves, and a plotting chronograph, the last-named having been devised with the help of the Cambridge Scientific Instrument Co. These appliances have been originated by Dr. Rosenhain at the National Physical Laboratory. Great interest was expressed in them, particularly in the design of furnace for taking thermal curves. In order to obtain as nearly as possible a constant rate of heating or cooling of the metallic specimen a tubular furnace is erected vertically in which a "regular temperature gradient is established and steadily maintained while the specimens whose heating and cooling curves are to be taken are moved at any desired rate from the cold to the hot end of the furnace or *vice versa*." Heating and cooling curves obtained in such a furnace and in conjunction with the plotting chronograph show that very satisfactory results have been obtained. The power consumption with the hot end at 1000° C. is a kilowatt. No figures for higher temperatures have been given, and it will be interesting to have those stated when they have been determined.

With regard to the plotting chronograph, the author's endeavour has been to originate an instrument which shall furnish an inverse rate curve "plotted to an adequately open scale." The apparatus is not as yet entirely self-recording, but represents a considerable step in this direction, and it gives the curve obtained with no other human intervention than the periodic tapping of a key.

The paper by Prof. Read and Mr. Greaves, of University College, Cardiff, contains an account of their investigations on nickel-aluminium and nickel-copper-aluminium alloys, more particularly the light alloys of the last-named group, and is a continuation of their earlier work on the heavy alloys of the same metals. They find that, as regards the ternary alloys, copper and nickel can replace each other without the resulting properties being affected, and, in fact, that certain characteristics of the alloys are determined by the total percentage of copper and nickel present. As they point out, this is intelligible in view of the fact that the two metals possess almost identical densities and very similar atomic volumes. Moreover, micrographic analysis shows that the internal structure of the alloy scarcely alters when the one metal replaces the other. Inasmuch as nickel costs about three times as much as copper, and its melting point is nearly 400° C. higher, it is clear that it cannot compete with it economically in the case of such alloys, except perhaps in a few instances where the need for resistance to corrosion in certain liquids is sufficiently imperative to outweigh considerations of expense.

A very useful compilation of etching reagents and their applications to metallography was presented by

Mr. O. F. Hudson. This work had been undertaken at the request of the Publication Committee of the institute, and in preparing it Mr. Hudson received and incorporated methods adopted by well-known workers both in America and this country. The paper deals more especially with the final stage in the preparing of specimens for microscopic examination, but as the author points out, the effects of previous operations must always be borne in mind. There is now an increasing consensus of opinion among the most skilled metallographers that grinding on mechanically-driven discs produces too severe an alteration in the surface structure of a metal or alloy, which is likely to create difficulties in their microscopic interpretation after etching, and that hand grinding, although slower, is much more trustworthy. This is neither more nor less than a return to the technique of the late M. Osmond, whose skill in the preparation of a specimen for microscopic examination has never been surpassed. The discussion on Mr. Hudson's paper was in a high degree illuminating, and showed the institute members at their best. When the complete paper and discussion are published they will certainly be a standard work of reference.

Four other papers were submitted. Of these, that by Mr. Whyte, on the microchemistry of corrosion, and that by Mr. Haughton, on the constitution of the alloys of copper with tin, were read and discussed. The remaining two were taken as read, and will be discussed by written communications.

H. C. H. CARPENTER.

SUPPLIES OF LABORATORY AND OPTICAL GLASS APPARATUS.

REPORTS OF THE BRITISH SCIENCE GUILD.

THE British Science Guild has just issued two reports dealing with matters of national moment at the present time. One is concerned with the provision of glass apparatus for educational purposes, and the other with optical glass and the position of technical optics generally in this country. The reports are here reprinted, and it will be seen that they are both informative and helpful. First, with regard to laboratory ware, it appears that, as the result of an inquiry instituted by committees of the guild, working in co-operation with the Association of Public School Science Masters, about three-quarters of the schools or other bodies requiring laboratory glassware have undertaken to use British glass during the war, and for a period of three years after, provided that the price is not prohibitive. As explained in a letter to NATURE of February 18 (p. 670) the British Laboratory Ware Association has made arrangements for the supply of laboratory glassware and similar materials from British manufacturers. The British Science Guild has, by its action, presented the association and British glass manufacturers generally with an assurance of support which should be of the greatest value to them.

The report of the Technical Optics Committee of the guild should cause serious attention to be given to the establishment of a British Institute of Technical Optics. In the last annual report of the guild it was pointed out that this necessity had been impressed upon the education department of the London County Council continuously during the past twelve years. Scientific experts, leading members of the optical industry, and educational experts have combined to urge the paramount importance of the definite proposals which have been formulated, but the scheme still hangs fire. Meanwhile our scientific and industrial rivals on the Continent, taking note of successful developments on a small scale which have been originated here, have gone forward to new developments with increased vigour and with highly successful results.

(1) PROVISION OF GLASS APPARATUS FOR EDUCATIONAL PURPOSES.

In the past practically all the glass and procelain apparatus used in chemical laboratories in this country has been manufactured in Germany and Austria. As the supply is now cut off and the stocks held by British dealers are almost exhausted, the problem of obtaining apparatus for educational and technical purposes has become a serious one.

The Joint Committee is informed that efforts are now being made by several firms to introduce the manufacture of glass apparatus into this country, and being in hearty sympathy with these efforts, it has considered in what way the British Science Guild may best assist. In these efforts the committee has co-operated with the Association of Public School Science Masters, and has taken action along two main lines, viz. :—

(A) Endeavouring to obtain assurances of support for British makers of educational glass ware after the war as well as now.

(B) Obtaining information from educational institutions respecting the principal types and sizes of glass apparatus in greatest demand.

(A) *Assurances of Support for British Makers of Scientific Glass Ware.*

It is understood that the efforts during the last three months by certain British glass manufacturers have been attended with satisfactory results as regards the quality of the products. Economic and manufacturing conditions have prevented British glass apparatus being sold at so low a price as has been paid in the past for German material. As these conditions will probably remain unchanged, British manufacturers have been naturally disinclined to expend the necessary capital in establishing the proposed new industry here while there is every likelihood that they will be undersold in the British market by their competitors when the war is over. The Joint Committee is informed that this has acted as a strong deterrent to British glass manufacturers contemplating the production of scientific glass apparatus.

The Joint Committee therefore has endeavoured to ascertain how far it is probable that educational institutions would undertake to buy only British-made glass and porcelain apparatus during the war, and for a period of three years after.

Inquiries were made in this direction by the hon. secretary of the Association of Public School Science Masters, who is a member of the Joint Committee, from the headmasters of all schools represented on the Headmasters' Conference. Out of the hundred and ten (110) schools so represented, no fewer than seventy-eight (78), *i.e.*, 71 per cent., have definitely promised to authorise their science staffs to purchase, as far as possible, only British-made glass apparatus during and for a period of three years after the conclusion of the war. As these promises have been received from almost all the largest schools, both boarding and day, it may be assumed that manufacturers as well as dealers will receive adequate support from the "conference schools."

The guild also issued about 750 letters of inquiry to—

(*a*) Local education authorities.

(*b*) Governors of secondary schools.

(*c*) Governing bodies of technical institutions.

(*d*) Senates of universities and university colleges, and has received a very large number of replies.

The proportion of definite replies coming in at once has been smaller than in the case of the public schools from the fact that various committees have had to be consulted before definite promises could be given, but the replies which have been received have been quite satisfactory—of the definite replies received about 72 per cent. are sympathetic, and promises are given to purchase only British-made apparatus as requested, subject in many cases to the proviso that the increased cost is not prohibitive.

A considerable number of the replies, while generally sympathetic, give no guarantee, the reason being in most cases that the matter rests with a higher authority, such as a county council, or board of governors, from whom no definite reply had been obtained. Some authorities, also, while sympathetic, do not feel able to bind their successors, and one authority suggests that only the purchase of German and Austrian apparatus should be barred.

The endeavour to obtain the value of the apparatus used in such institutions has not resulted in any very precise information, but from the facts before the committee it is clear that the value of such apparatus must at least run to some thousands of pounds.

(B) *Types and Sizes of Apparatus most in Demand.*

Inquiries as to the principal types and sizes of apparatus most generally used have been made on behalf of the Joint Committee from public schools and technical schools. It was felt by the Joint Committee that this information would be of considerable value to glass-makers, as there is a very strong feeling among those concerned with the chemical apparatus trade that at the present time flasks, beakers, basins, etc., are supplied in an unnecessarily large variety of shapes and sizes.

Judging from the replies received from the institutions above referred to, the following represent the apparatus most in demand:—

TEST TUBES.—6 in. × $\frac{3}{4}$ in., 2 in. × $\frac{1}{4}$ in., and, in smaller quantities, 6 in. × 1 in., 5 in. × $\frac{5}{8}$ in., and 2 in. × $\frac{1}{2}$ in.

BEAKERS.—Squat form, lipped, 200 c.c., 300 c.c., and, in smaller quantities, 150 c.c., 500 c.c., 1000 c.c.

BEAKERS.—High form, in the same sizes as above, but in smaller quantities.

FLASKS.—Flat bottom, 100 c.c., 250 c.c., 500 c.c., and, in smaller quantities, 1000 c.c., 1500 c.c., 2000 c.c.

FLASKS.—Round bottom, 250 c.c., 500 c.c.

TUBULATED RETORTS.—150 c.c.

FUNNELS.—6·5 cm.

DISTILLING FLASKS.—100 c.c., 250 c.c., 500 c.c.

EVAPORATING DISHES.—50 c.c., 100 c.c., 200 c.c., and, in smaller quantities, 1000 c.c., and 2000 c.c.

CRUCIBLES.—15 c.c. and 25 c.c.

In conclusion, the Joint Committee desires to express its strong conviction that every effort should be made to facilitate and encourage the manufacture of glass and porcelain apparatus in the United Kingdom. It therefore urges the advisability of asking the Board of Trade to watch the new industry, and, if necessity should arise, to use its endeavours to modify any restrictions at present existing which may be detrimental to the carrying on and extension of the industry.

(2) THE MANUFACTURE OF OPTICAL INSTRUMENTS AND MATTERS RELATING THERETO.

NECESSITY FOR ACTION.

The British Science Guild, having inquired carefully, by means of a strong and representative expert committee, into the effect of the outbreak of hostilities on matters of national importance connected with the manufacture of optical instruments in the country generally, submits this report to the Government, and in doing so emphasises the pressing urgency of the subjects referred to.

Supply of Glass. (a) The General Case.

(1) In the first place the inquiry referred to was directed to the consequences of the *sudden stoppage of the supply of German optical glass* on which this country had increasingly relied for many recent years. A letter of inquiry asking for information on six specific points was addressed to representative firms in the optical trade. The results of these inquiries has been such as to satisfy the guild that the supply of optical glass available for the manufacture of telescopes, binoculars, range-finders, and other service instruments is sufficient for the purpose. Under this head there seems to be no call for any special effort to improve upon existing conditions, though the *supply of English glass has not always been adequate in quantity, and delays have been experienced in obtaining quick delivery.*

The representative of Messrs. Chance Bros., who was a member of the Technical Committee referred to above, has assured the committee that since the outbreak of hostilities the firm has considerably increased (in fact, quadrupled) the capacity of its plant for the manufacture of optical glass, and is fully prepared to extend this plant still further.

(b) Photography and Micrography.

(2) With regard to the manufacture of photographic and microscopic lenses the case stands otherwise. The requirements of the manufacturing trade in these respects are not definitely standardised as in the case of the instruments already referred to. To facilitate new and important developments it is necessary that the lens manufacturer should have recourse to a greater variety of glasses than are, in fact, manufactured at the present time in this country. It is further necessary that larger stocks should be held than is the custom at the present time of the various glasses produced. The guild, therefore, is of opinion that serious inconvenience is certain to result to the manufacturing trade if the supply of German glass is cut off for any considerable length of time. The amount of glass demanded, especially for photographic purposes, is very considerable, and the guild is of opinion that the attention of the authorities might usefully be directed to this opportunity for a considerable development of British glass manufacture in this direction. One difficulty the guild understands to be the defective supply of pure barium compounds.

(c) Variety of Glass Obtainable Inadequate.

(3) From a wider point of view and more generally, the variety of English glasses offered is not sufficient for all the requirements of optical instrument-makers, especially for the more recently developed and important optical designs. Thus, whilst the leading English firm listed only twenty to thirty types of glass, the leading German firm listed about seventy types, every one stocked. Barium glass of high refraction and low dispersion, *i.e.* having a high value of the "anti-dispersion" coefficient, is reported as specially difficult to obtain in England.

Research.

(4) The desirability of the provision of facilities for research upon the manufacture of optical glass has been carefully considered and has been found to be a difficult question. From the evidence submitted it appears that if one special object of research could be attained the result would be highly advantageous. This object is the discovery of a refractory lining of the melting "pot" which would resist the action, at

melting temperatures, of the materials used in the glass mixtures, and leave the contents of the pot uncontaminated at the conclusion of the operation. This research would probably be a long and costly one, and is such as might most appropriately be undertaken by the National Physical Laboratory, especially as certain details in the manufacture of optical glass may come under review during the inquiry.

Authoritative Testing of Glass.

(5) In another direction evidence was submitted to the guild to the effect that it would be distinctly advantageous to the optical trade if *increased facilities for the authoritative determination of the optical constants* and *relative absorption of samples of glass* submitted for test could be provided at the National Physical Laboratory

THE FUTURE.

Facilities for Education a Matter of Great Urgency.

(6) In still another direction evidence, additional to evidence collected before the outbreak of hostilities, was elicited that the *facilities for education in technical optics are very inadequate.* It was shown that not only could some of the present difficulties connected with the supply of optical glass probably be diminished, but that the output of optical instruments for national purposes would be increased, and that the optical trade would be substantially benefited in other directions if such facilities were largely extended. The Technical Optics Committee of the guild was originally appointed, early in the year 1914, for the purpose of "inquiring into the need of an Institute of Technical Optics and the steps to be taken in connection therewith, and in due course it submitted a "statement" on the subject, which was published in the annual report of the guild, 1914, pp. 31–34. The committee had further reported to the Executive Committee of the guild at its July meeting, and the report was adopted with a few alterations, and is printed at the end of this report.

(7) When the Technical Optics Committee met after the vacation, the other matters, apparently of more immediate urgency, referred to in this report, had arisen and took precedence of the earlier matter. In investigating these new questions it has become strongly evident that the earlier matter is of *supreme and pressing importance.*

The guild therefore recommends:—

(A) That better provision should be made at the National Physical Laboratory for the testing of samples of glass as to their physical and optical properties, and that the director of the National Physical Laboratory be approached on the subject.

(B) That facilities should be provided as speedily as possible for the carrying out, at the National Physical Laboratory, or elsewhere, of the researches connected with the manufacture of optical glass referred to in this report.

(C) That steps should be taken as speedily as possible to give effect to the recommendations of the previous report of the Technical Optics Committee of the guild in the direction of providing facilities for systematic, scientific, and manual training in technical optics, and the guild, recognising that educational training requires time, is strongly of opinion that this question is urgent and that the organisation of optical training should be taken in hand at once.

PREVIOUS REPORT REFERRED TO IN PARAGRAPH C, DATED JULY 14, 1914.

Proposed Establishment of an Institute for Technical Optics.

The British Science Guild has had under consideration for some time the inadequate provision for, and the unsatisfactory state of, the technical training in optics in the British Isles. The subject was brought to its notice by Sir Thomas Barlow, formerly president of the Royal College of Physicians, in a communication to the president of the guild, and was considered to be of such importance by the Executive Committee that a Special Committee was formed to deal with it. The Special Committee has now reported.

The establishment of such an institute has been under discussion for some years, and there is a remarkable consensus of expert opinion, both as to the necessity and the urgency for action, from many and diverse points of view, scientific, industrial, and national.

The London County Council, which has gone into the matter very thoroughly, has not felt itself in a position to provide from the funds under its control the initial capital expenditure of some 40,000*l.* for the erection and equipment of the proposed institute, although a site was actually purchased for the very purpose by the governing body of the Northampton Polytechnic Institute so far back as 1908. The Finance Committee of the council is understood to be of opinion that the project is so essentially of national importance that it would be unfair to saddle London ratepayers with the whole cost. It is, however, believed that if the question of capital expenditure can be solved, the maintenance of the institute could be assured by grants from the Board of Education and from the London County Council, and by students' fees. As an additional reason for expedition, it may be pointed out that the governing body of the Northampton Polytechnic Institute may not be in a position to carry much longer the heavy burden of the mortgage interest on the purchase money above referred to, and the amortisation of the capital amount.

GEOLOGY IN RELATION TO THE EXACT SCIENCES, WITH AN EXCURSUS ON GEOLOGICAL TIME.[1]

IT is often said that figures can be made to prove anything; and certain it is that a series of arithmetical operations does sometimes serve as introduction to very strange conclusions. The fault, of course, is not in the tool, but in the hand that uses it. In the larger issues of geology especially, where the gulf to be bridged between data and conclusions is so often a wide one, ingenuity of reasoning ought surely to be accompanied by a due sense of responsibility in the handling of figures. Calculation, in such applications, is by no means so simple an art as it may appear. In wrestling with problems of the kind indicated, and, I must add, in reading some very fascinating speculations by geologists of high standing, I have often wished that some obliging mathematician would put forth a small manual of applied arithmetic for the guidance of workers in the descriptive sciences. There are absolutely necessary precautions to be observed when calculation is based upon data always partial and at best roughly approximate, and these precautions are too often neglected. To be safe, we must have some conception of the probable error attaching to our observations, and we must note how the initial errors may be multiplied in the process of calculation. Especially there is the cumulation of error which must ensue when results obtained in this fashion are used as links in a chain of deduction. Here it is quite inadequate to say that the chain is no stronger than its weakest link; it is of necessity far weaker than its weakest link.

[1] From a Presidential Address delivered before the Yorkshire Geological Society by Alfred Harker, F.R.S. Reprinted from the Proceedings of the Society.

Without entering into these matters, some of which, as I have suggested, call for expert aid, I will take for illustration a single point, the frequent abuse of *the average*. Say that we wish to determine the amount of mud annually carried down by the Nile. Since there are variations, both seasonal and casual, we must take a sufficient number of observations, properly distributed in time, and an average, duly weighted, will then give us as good a result as the nature of the case admits. But now suppose that we wish to know the amount of sediment carried by all the rivers of the world. We have data for nine rivers, data which are likely to differ much in respect of probable error. Accepting them, however, as they stand, it appears that the water of the Rio Grande carries one part in 291 of sediment, that of the Uruguay River only one in 10,000, the other seven rivers giving intermediate values. The highest figure is thus thirty-four times as great as the lowest. Some geologists will simply take a mean of the nine figures, and proceed contentedly to use this result in the most far-reaching conclusions. I do not believe that a mean of nine figures so discordant can afford any information of quantitative value. The average must be extended over a much wider area, before a result is obtained of which we can legitimately make use.

Where dynamical principles enter into the problem, the pitfalls which await the unwary are sometimes less evident. I will take as an illustration the case of models, such as have been constructed to elucidate the mechanism of folding and faulting. In no case, so far as I am aware, have geologists had regard to the conditions which are necessary in order that a model may correctly represent the working of the original. The various forces concerned must bear their proper ratios. Since the weight (for a given material) is reduced proportionally to the cube of the linear dimensions, the other forces must be reduced in the same ratio; and it is, in fact, impossible to make this adjustment as regards the internal forces which resist deformation and fracture. Moreover, the velocities of the moving parts should be reduced in proportion to the square root of the linear dimensions; and this makes it hopeless to think of imitating the slow processes of mountain-building. Models of this kind may afford useful *geometrical* illustrations, but can throw no light on *dynamical* problems. The same remark applies to models of glaciers; but here there is no need to go to artificial models to illustrate my point. Some geologists still argue from the behaviour of an Alpine valley-glacier to that of a continental ice-sheet, without perceiving how completely the different scale of magnitude must modify the mechanical conditions.

Experiment has undoubtedly afforded valuable help in the study of particular questions in the domain of physical geology, and this is to be recognised with gratitude. As regards the larger and more complex problems, however, imitative experiment labours under the same disadvantage as mathematical analysis. Any concrete problem can be treated only in an arbitrarily simplified form, and among the conditions which cannot be realised in the laboratory may be some which in nature are of vital importance. Especially will this be the case where the time element enters.

There is, however, another department of experimental geology in which we are justified in expecting results of very high value. I allude to the study of the conditions of formation and stability of different minerals, with the object of elucidating the mode of origin of igneous and other rocks. The artificial reproduction of many of the rock-forming minerals has engaged the attention of chemists, especially in France, during the last hundred years. Fouqué and Michel-Lévy succeeded even in imitating some of the simpler types of igneous rocks. These researches have furnished the petrologist with useful information, but it is information mostly of a very general kind. The laborious investigations now being carried out, more particularly in the Geophysical Laboratory of the Carnegie Institution of Washington, are of a different order, systematic and precise to the highest degree attainable. Their chief object is to apply to the crystallisation of igneous rock-magmas the methods which have proved so fruitful in other branches of physical chemistry. This necessitates working over a far wider range of temperatures than is usual in laboratory operations, and must sometimes include high-pressure work also. It involves, too, other practical difficulties, arising especially from the slowness with which equilibrium is established in many of the transformations investigated. Owing perhaps to these obstacles, and partly, it may be, to the scarcity of enlightened millionaires—for expense is here a weighty consideration—research on these lines has not yet been widely taken up. Meanwhile it is scarcely too much to say that Dr. Day and his colleagues at Washington are already laying the foundations of an exact science of petrogenesis.

Of all geological questions involving the numerical element, none has been more frequently canvassed than the problem of geological chronology, and none has excited more general interest. Since, moreover, it introduces several points germane to my subject, a brief glance at its history and present state will not be wasted. I suppose it has happened to most of us, when relating how in past times the mammoth roamed the plains of Holderness, or how coral-reefs once flourished where the Craven hills now stand, to be met by the inquiry: How long ago was that? The answer was perhaps to the effect that geology does not deal with the ordinary measures of time, but has its own system of chronology, not translatable into years and centuries. I must confess, however, to a sense of inadequacy in such a reply, and some sympathy with the lay inquirer who is thus silenced but not satisfied. It seems a matter of reasonable regret that a science which deals with the history of past events should have no definite time-scale, by which those events could be ranged in a correct perspective.

No such reflection, it is safe to say, disturbed the minds of the early Uniformitarians, the founders of modern geology. Their reaction against the older catastrophic school led them constantly to lay great stress on the extreme slowness of geological processes, and they thus came to assume unlimited time for the past changes to which the stratified rocks bear witness. To Hutton there was "no vestige of a beginning, no prospect of an end"; in other words, he regarded geological time as infinite, and could no more contemplate reckoning it in centuries than numbering the sands on the shore. Later this position was reinforced from another quarter, as Darwin's doctrines gained acceptance; for these were held to push back to an immeasurably remote epoch the beginning of life on the globe. Geologists and biologists alike saw no reason for limiting their prodigal drafts on the bank of time.

From this comfortable attitude they were startled, as by a bombshell, some fifty years ago, when William Thomson, afterwards Lord Kelvin, published the first of his contributions from the mathematical side to this and cognate subjects. He pointed out that, apart from any changes on the surface of the globe, our planet as a whole must be undergoing a change of a secular, and so irrevocable, kind; viz., a continual loss of energy in the form of heat, as proved by the observed temperature-gradient. Since the store of energy cannot be inexhaustible, we must deduce both a beginning and an end of the existing geological *régime;* and Thomson endeavoured to set a limit to its past duration from a discussion of the rate of cooling of the globe. A parallel line of argument was based on the cooling of the sun.

Now as regards the validity of the general criticism there can be, of course, no doubt. Huxley's halting defence of what was then the orthodox position was easily broken down, and a wholesome check was given to the extravagance of the geologists. When we turn, however, from the destructive to the constructive part of Kelvin's argument, the case is different. The time to be allowed for the geological record was stated at first with considerable latitude, but was afterwards narrowed down, until, in 1899, Lord Kelvin concurred in Clarence King's conclusion that the globe was a molten mass about twenty-four million years ago. It is rather remarkable that so many geologists were found willing to submit to this narrow limitation. Doubtless they were impressed by the prestige of Lord Kelvin's authority, and perhaps some of them were influenced by a vague feeling that a result arrived at by strict mathematical reasoning is thereby entitled to credence. But, as has been so often pointed out, and so often forgotten, what you get out of the mathematical mill depends upon what you put into it. The reasoning may be unimpeachable, but it merely proves that, if certain assumptions be granted, certain consequences will follow. It may be that Lord Kelvin himself, in the enthusiasm of enforcing his conclusions, did not always recall the foundations on which they rested, and it is to be suspected that many geologists read no more than the conclusions.

Kelvin's argument was based necessarily upon a number of assumptions. At the present time, in the light of fuller knowledge, it is sufficient to note one, which in 1862 seemed little open to question. Kelvin recognised that, while the earth is certainly losing heat, "it is possible that no cooling may result from this loss of heat, but only an exhaustion of potential energy, which in this case could scarcely be other than chemical affinity between substances forming part of the earth's mass." This, however, he dismissed as "extremely improbable," and proceeded on the assumption that heat is the only form of energy to be reckoned with. Since the discovery of radium we have learnt that the earth possesses a vast store of potential energy in a highly concentrated form then unsuspected. Strutt has calculated, from data of a very simple kind, that the observed temperature-gradient can be wholly accounted for by radio-activity, if the rocks to a depth of forty-five miles contain as much radium as those at the surface. In other words, the heat generated by radio-active changes within this relatively thin crust will, on that supposition, be sufficient to compensate that lost at the surface. Clearly, therefore, the actual rate of cooling of the globe—if indeed it is cooling—must be far less than that adopted in Kelvin's calculation, and his estimate of the age of the earth must be enormously increased.

This is not all. A study of the various radio-active elements contained in minerals and rocks has shown that it is possible, in certain favourable cases, to calculate directly their age in years. Some estimates of this kind have been made, and the results are liberal enough to satisfy the most exacting claims of what may be called the reformed Uniformitarian creed.

With this turning of the tables one might suppose that the old controversy would come to an end. But the reversal of the situation is, in fact, more complete; for meanwhile there has arisen a formidable minority of geologists who contend, on geological grounds, for estimates of time no more elastic than Lord Kelvin's. The question is still, in great part, one between geologists and physicists, but it is now the geologists who offer us the stinted measure and the physicists the more liberal one.

It is not my purpose to discuss in detail the various geological arguments which have been advanced for limiting the age of the earth to a span of 80 or 100 millions of years. The method of procedure is broadly the same in all. A computation is made of the rate at which some fundamental geological process is going on; it may be the lowering of the land-surface by erosion, or its destruction by solution, or the deposition of sediment, or the addition of salt to the sea. Some estimate is then made of the total result of the process throughout geological time. Having the annual rate of increment and the total amount, simple division gives the measure of the time in years. The observational data employed in these calculations are of a very precarious kind, and it would not be difficult to point out instances of that levity in the handling of figures to which I have adverted. But the fundamental weakness of all such reasoning lies in the assumption that the present rate of any of these geological processes can be adopted as equivalent to its average rate throughout the whole time.

The existing configuration of the globe, and all the physical conditions that go with it, have been attained in consequence of a prolonged evolution. If we believe that, as the net result of all its vicissitudes, the land-area has on the whole been growing in extent, in complexity of distribution, in boldness of relief, we must believe also that differences of temperature, of humidity, of climate generally, between different parts of the globe have become progressively more accentuated, and that all geological activities have been quickened as the world has grown older. While there is difference of opinion concerning these *secular* changes, there can be no doubt as regards the great *cyclical* changes which have been repeated several times in the history of the earth: the cycle beginning in each case with an epoch of important crust-movements and including the train of consequences which follow upon this new step in the evolution of the earth. Such a cycle was initiated at an epoch not long remote by geological reckoning, and we are living in consequence in a time of more than ordinary geological activity, with the continental masses rising higher than their average level, and with large tracts of newly deposited strata exposed to the attack of destructive agents.

For these reasons I am of opinion that the present rate of erosion, and of its correlative sedimentation, is much higher than the average rate, and that any calculation based upon it must greatly under-estimate the duration of geological time. I do not ask you necessarily to concur in this conclusion, but at least to suspend judgment in the matter: for it will assuredly be a misfortune if geology, so lately freed from one bondage, should fall straightway into another no less galling. This at least is certain, that every one of the various geological processes which have been discussed in this connection, is controlled by conditions which cause its rate to be very variable. It is a clock which now hurries and now creeps, or stands still, and it can never be trusted as a time-keeper. Even for the most recent chapter of geological history we can make no approach to certainty on these lines. Attempts have been made, for example, to estimate the time since the final retreat of the ice in North America from the rate of recession of the falls of Niagara; but the evidence shows that this rate has varied widely even during the last half-century, and Gilbert, after a careful study of all the data, refrains from offering any opinion on this point.

Must we then abandon all hope of any practicable measure of time in geology? I do not draw this conclusion, but rather that we must search outside strictly geological phenomena for some physical process of which the rate is not affected by any disturbing conditions. There are, I think, only two classes of changes for which so much can be claimed—the transformations of the radio-active group of elements and the astronomical movements. It seems not improbable that in one or other of these two directions the solution of the problem may eventually be found.

The chemists have taught us that radium is derived from the spontaneous breaking up of uranium, the change taking place apparently in two stages and involving the liberation of three atoms of helium. But radium itself disintegrates spontaneously, giving the radium-emanation named niton and liberating another atom of helium. Niton in its turn undergoes disintegration, and so on through a succession of changes. The final product is lead, and in the gradual conversion of uranium to lead eight atoms of helium in all are set free. Of these various spontaneous changes some proceed with extreme slowness, others with comparative rapidity; but in each case there is a constant rate which, so far as experiment has tested it, is independent of temperature or pressure.

Prof. Strutt has shown that this gradual liberation of helium can be made the basis of a method of estimating the absolute ages of minerals and rocks. For example, phosphates and some iron-ores are rich in radium, derived from uranium. They also contain helium, and the ratio of helium to uranium is found to be higher in the older deposits. Estimates of age calculated from these data give high figures: *e.g.* the age of the hæmatite overlying the Carboniferous Limestone in Cumberland is given as 140 millions of years, and even that of the Eocene iron-ores of Antrim thirty millions. The results show some irregularities, and it is, of course, admitted that the method has its own difficulties. If, however, the chief source of error is, as appears probable, the loss of helium by leakage, the figures found will be under-estimates. Helium comes from the thorium series of derivatives as well as from the uranium series, and this is to be taken into account where thorium is found. Zircons from various igneous rocks have also been examined by Strutt, and found to give consistent results as regards the helium-ratio. Mr. A. Holmes has approached the question in a different way, by considering the ratio of lead to uranium in various minerals rich in the latter element. The igneous rocks of the Christiania district, of Devonian age, are in this way calculated to be about 370 million years old. For the Archæan rocks of different countries the estimates range from 1000 to 1600 millions of years. Holmes's results are in general nearly twice as high as those of Strutt; but, if we bear in mind the error due to the escape of helium, which is proved to take place, a discrepancy to this extent is no more than should be expected at this early stage of the inquiry.

The other method which has been suggested for obtaining an absolute measure of geological time is of a more speculative kind, although the principle of it is sufficiently simple. It consists in detecting some clearly marked rhythm or cycle in the geological record, and correlating it with one of the known periodic movements of the earth. It was on these lines that Croll attempted to explain the recurrent glacial epochs; but more to our present purpose is the theory which Blytt has based upon a study of the alternations observed in a succession of sedimentary strata. The most important astronomical cycle of long period is doubtless that which depends upon the precessional movement, by which the relation of summer and winter to perihelion and aphelion is gradually changed. This involves a change in the relative lengths of summer and winter, and must undoubtedly exercise a marked effect upon climatic conditions, though there is much difference of opinion concerning the exact nature of this effect. Changes of climate may in their turn cause differences in the nature of the sediments deposited successively at a given place, differences which will repeat themselves in a cycle corresponding with that of the precession. Probably the most noticeable effect will be a recurrence of limestones and chemical deposits alternating with detrital sediments.

If the matter were no more complex than this, it would be sufficient, where such alternations can be detected, to count them, as we count the rings of growth of a tree, and reckon 21,000 years for each sedimentary cycle, that being the period of the precession corrected for the movement of the perihelion. If the alternations can be distinguished only in some parts of the succession, some hypothesis must be devised to take account of the intervals. Gilbert has discussed in this way a succession of beds, 3900 ft. thick, forming part of the Cretaceous system in Colorado. Alternations of calcareous beds with shales come in four times, being separated by unbroken thicknesses of shale. Gilbert calculates for the part of Cretaceous time represented a duration of about twenty million years, with an uncertainty indicated by the number 2 as a "factor of safety."

We have to remember, however, that sedimentation is controlled by other conditions besides climate, and climate depends upon other causes besides the precession of the equinoxes; and, further, that most of these contributing causes cannot be described as periodic in any intelligible sense. There is, it is true, a second astronomical movement to which both Croll and Blytt have made appeal, viz., the variation in the eccentricity of the earth's orbit. This goes through a period of about 90,000 years; but there are considerable irregularities which repeat themselves in the course of 1,450,000 years, giving a larger cycle which embraces sixteen of the smaller cycles. The change of eccentricity must modify the effect of the precessional movement; but Blytt argues that it will also react on the ellipsoidal shape of the globe itself, and so give rise to a displacement of shore-lines. He claims to have traced this effect, as well as the climatic cycle, in such cases as the succession of the Tertiaries in the Paris basin and the Isle of Wight. His conclusion is that Tertiary time comprises two of the larger cycles, *i.e.* about three million years.

It has usually been assumed that the year is too short a period to leave any recognisable mark on the geological record. This is probably true in general, but in certain favourable circumstances it may perhaps be possible to count annual layers of sediment. De Geer has recently attempted this in the case of certain finely laminated clays of late Glacial and post-Glacial age in Sweden. The material was brought down by sub-glacial streams at a time when the ice had retreated to the higher ground. Consequently the seasonal variations were strongly marked, and the accumulation of sediment was rapid enough to yield an appreciable thickness in each year. From such data De Geer has estimated that the recession of the last ice-sheet occupied a duration of about 5000 years; and he further gives 7000 years as the lapse of time since the recession of the ice.

As regards the longer astronomical cycles, it is clear that the argument involves a large element of hypothesis, and its application, as Blytt allows, is beset with practical difficulties. It possesses a special interest as lending a new significance to the details of stratigraphy, but as a means to the establishment of a geological chronology its value is at present only potential. The radium method of evaluating geological time seems to offer more immediate promise.

In conclusion, it is pleasant to note how these applications of chemistry, astronomy, and meteorology, not merely to general principles of geology but to a definite geological problem, emphasise the fundamental unity of the sciences, and illustrate the powerful aid that may be rendered by one to another.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. ROY DEAN, professor of pathology in the University of Sheffield since 1912, has been appointed to the chair of pathology and pathological anatomy in the University of Manchester.

DR. ADA E. MILLER has been appointed lecturer on school hygiene by the Edinburgh Provincial Committee for the Training of Teachers, in succession to Dr. J. Douglas Cameron, who has resigned.

IT is stated in *Science* that the committee on education of the United States House of Representatives has reported favourably a Bill establishing a National University in Washington. According to the Bill an initial grant of 100,000*l.* would be made. The university would be devoted to research and graduate work and no degrees would be conferred.

A REUTER message from Delhi reports that on March 22 Sir Harcourt Butler introduced in the Imperial Legislative Council a Bill for constituting a teaching and residential university at Benares, with special facilities for instruction in the Hindu religion. He referred to the scheme as the commencement of a new era in university organisation in India.

DR. ALEX. HILL, principal of the Hartley University College, Southampton, is reported by the *Times* to have said in an address on Monday that he had recently been preparing a war-roll of the Empire universities, and had found that the average contribution in men from universities and university colleges was just above 50 per cent. He added:—"It is a surprising fact that the contribution of German universities to the forces of the German Empire in the field is less than 20 per cent." This statement as to German university students is not, however, correct, judging from the statistics we gave last week (p. 81). Seventy-five per cent. of the students of German universities are in the field, and about 80 per cent. of the students of the Technical High Schools are also on active service.

SIR PHILIP MAGNUS retires, we understand, to-day from his official connection with the City and Guilds of London Institute. It is now no fewer than thirty-five years ago since he was appointed organising director and secretary of the institute, a post which he held for eight years, during which he was responsible for the initiation of the institute's work and for the schemes of the Finsbury College and Central Technical College, which have since developed so successfully. In 1888 his activities were transferred to the examinations department, or, as it is now known, the department of technology of the institute, where they found a wider field in assisting and guiding the development of technical instruction all over the country. The ability of his organising powers is sufficiently evidenced by the manner in which the department, without any assistance from Government and without the power of the purse possessed by a department of State, has made the name of the City and Guilds of London Institute known to technical schools all over the British Isles, and, indeed, in the Dominions beyond the Seas. To the work of Sir Philip Magnus in the office which he is vacating, his careful insistence on the necessity of making technical instruction a true education in principles, his continual study of the best means of adapting courses to the needs of students and manufacturers alike, and his unceasing endeavours to raise the standard of teaching, the progress of technical education in this country is greatly indebted.

THE first annual report, for the period ended December 31, 1914, submitted by the executive committee to the trustees of the Carnegie United Kingdom Trust has now been published. Mr. Carnegie during many years prior to 1912 gave large sums to local authorities in this country for the erection of public libraries, and to churches for the acquisition of organs. As the applications for these grants increased and their administration became more difficult, Mr. Carnegie decided to place the future administration of grants under the control of a permanent body of trustees. In 1913 he placed 2,000,000*l.* in trust so that the income of about 100,000*l.* a year should be available "for the improvement of the well-being of the masses of the people of Great Britain and Ireland." The report is full of interesting particulars, but attention can be directed only to a few typical facts. Organ grants are to be discontinued for the present. Mr. Carnegie has already expended 550,000*l.* in this direction in the acquisition of some 3500 instruments. A total expenditure of nearly 2,000,000*l.* has been incurred already on the erection of public libraries in the United Kingdom. The executive committee has, we notice, intimated to the authorities of the Household and Social Science Department of King's College for Women, London, that it is prepared to meet half the cost of the erection of a library building, on certain conditions. The committee has also made an offer in the direction of endowment to the Central Bureau for the Employment of Women. The report throughout gives the impression of wise and sympathetic administration of a princely endowment.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 18.—Sir William Crookes, president, in the chair.—Prof. W. H. **Bragg**: Bakerian Lecture: X-rays and crystalline structure. The atoms of crystal may be conceived—in various ways—as arranged in a series of parallel planes, each capable of reflecting a small fraction of an incident pencil of X-rays. If the spacing of the planes is d, the wave-length λ, and the angle between the rays and the planes is θ, and if the relation $n\lambda = 2d \sin\theta$ is satisfied, where n is any integer, then the various reflected pencils are in the same phase and combine to give an obvious reflection of the X-rays. If this relation is not satisfied there is no reflection. The X-ray spectrometer is designed to measure the various values of θ at which reflection occurs in a given case. The angle can easily be determined to a minute of arc. Given d we can compare the wave-lengths of different X-rays. Given λ we can compare the spacings of various sets of planes of the same or of different crystals. By certain considerations the experiments can be made absolute and not merely comparative. In this way the structures of several simple crystals have already been found, such as rock-salt, diamond, iron pyrites, and so on. The reflections for various values of n, the integer in the formula, or, as they may be called, the spectra of various orders, differ amongst themselves in a surprising way. The intensities in the case of the most important planes in Iceland spar have recently been determined and give very interesting results. In the case of two pairs of planes the spacing is the same but the arrangement of atoms is different. This gives an opportunity of comparing the effect of arrangement apart from spacing, and it appears that the *intensity* of the reflection in any order is proportional to the weight of the planes which contribute to that order. Again, there are three calcite planes for which the arrangement of the atoms is exactly the same, but they differ in their spacings. The relative intensities follow a rule which has already been stated, viz., that the intensity in a reflection at an angle θ is inversely proportional to $\sin^2\theta$, other things being the same. Rules of this kind are needed if the method is to be used in the examination of more complicated crystals. The physical meanings that may be attached to these rules are of considerable interest.

Physical Society, February 26.—Dr. A. Russell, vice-president, in the chair.—Dr. C. **Chree**: Magnetic "character" figures, Antarctic and international. The paper makes use of magnetic "character" figures "0" (quiet day), "1" (moderately disturbed day), "2" (highly disturbed day) to investigate whether the incidence of disturbance at the base station of the Scott Antarctic Expedition, 1911–12, did or did not accord with the incidence of disturbance in temperate latitudes; also whether the "27-day period" could be recognised in the Antarctic data. The incidence of disturbance in the Antarctic was found to agree closely with that shown by the international lists, in spite of the fact that the disturbances in the Antarctic were much larger and more persistent than at any of the stations co-operating in the international scheme. The "27-day period" was clearly visible in the Antarctic records both in summer and winter, being as well developed there as elsewhere.—Dr. P. E. **Shaw**: The electrification of surfaces as affected by heat. The paper deals with anomalous electrical behaviour of various substances when subjected to heat. For example, a glass rod rubbed with silk is normally left positively electrified, but if the rod be passed through a bunsen flame, or heated in an electric furnace, and then allowed to cool it will be found on again rubbing with the silk that the glass becomes negatively electrified. Similar results were obtained with a number of materials, and various experiments are described which aim at determining the cause of the phenomenon. These seem to show that it is not due to the formation or removal of layers of any substance, solid or gaseous, but is probably due to surface strains in the material.—Prof. J. W. **Nicholson**: Electromagnetic inertia and atomic weight. The paper contains a mathematical deduction of a simple formula for the combined mass of two electrical charges when in proximity to each other. This mass is not the sum of their individual masses when far apart, if it be supposed that all mass of positive electricity, like that of electrons, is of electromagnetic origin. Applications are made of the formula to questions of atomic constitution and of radio-activity. A discussion is given of the evidence leading to the conclusion that the nuclei or cores of positive electricity in atoms are complex structures of electrons and even smaller positive nuclei. On this basis, emission of an α particle by an atom does not decrease its atomic mass by 4, a correction being necessary for the "mutual mass" of the α particle and the rest of the core. Estimates of the magnitude of this correction, in the case of radium and thorium passing into lead by the emission of particles, are given. From the value given by Soddy for the atomic weight of thorite lead we can deduce the average distance apart of the components in a radium nucleus. It is of the same order as the radius of an electron. Suggestions of further interesting applications of the precise formula for mutual mass are also contained in the paper

March 12.—Dr. A. Russell, vice-president, in the chair.—C. C. **Paterson** and B. P. **Dudding**: The estimation of high temperatures by the method of colour identity. Preliminary experiments are described in which the temperature of incandescent substances is estimated with a very fair accuracy by matching their colour with that of incandescent filament lamps working at appropriate efficiencies. These have previously been calibrated by comparison with a "black body" over a large temperature range. The comparisons are made in the field of a Lummer Brodhun photometer, and the method is shown to give the correct result for the melting point of platinum.—C. C. **Paterson** and B. P. **Dudding**: The unit of candle-power in white light. The paper describes the methods adopted at the National Physical Laboratory for minimising the difficulty of photometric comparison of white lights of different hue. A series of six sets of electric sub-standards are described varying in the tint of the light radiated from that of the pentane lamp to that of a tungsten vacuum lamp operating at 1·5 watts per candle. The absolute value of the unit of candle-power has been re-determined, as have also the corrections for humidity and barometric changes, while the probable existence of a temperature correction is discussed.—G. L. **Addenbrooke**: The relative losses in dielectrics in equivalent electric fields, steady and alternating (R.M.S.). After references to former work, especially on surface leakage, tables are given showing an intimate connection between the losses in steady and alternating fields, and that one can be predicted from the other to a first approximation. Exceptions are mentioned, and it is shown that there is heterogeneity in these cases. Curves of the losses from 1 to 4 seconds to 40 ~ are given for specimen dielectrics. Above 8 to 12 ~ both for "good" and "poor" dielectrics, these become rising straight lines. The salient features lie below about 16 ~. The formula $a+bn$ applies to all dielectrics for frequencies above about 8 ~, but not below. The a constant is always larger than, and bears only a very indefinite relation to, the steady voltage loss. Liquid dielectrics behave similarly to solid with certain differences, particularly that for a given resistance the ratio of the steady to the alternating loss is less than with solids. There is a great difference in the comparative ranges of the losses. For the dielectrics tabulated these vary in a steady field from 1 to 1,300,000, but the corresponding alternating losses vary only from 1 to 1,100.

Linnean Society, March 4.—Prof. E. B. Poulton, president, in the chair.—A. W. **Hill**: The germination of the cucurbitaceous genus Marah. The genus Marah includes some eleven species practically confined to the Pacific watershed of the western States of North America and the islands of Lower California. The genus is distinguished from Echinocystis and other genera with similar floral characters by its enormous tuberous root, associated with which is the peculiar mode of germination of the seeds. The petioles are fused to form a tube, and on germination this tube grows out, carrying plumule and radicle some distance into the ground, the cotyledons remaining hypogeal. The plumule finally bursts through the petiolar tube, and grows up into the air with sharply bent over tip. The petiolar tube is covered with hairs which appear to function as root-hairs.—Dr. Marie C. **Stopes**: New types of stem-anatomy in Cycadeoidea, with a well-petrified new species. A short account was given of two species of Cycadeoidea in which the internal anatomy is partially preserved, and also of a well-petrified new species showing very curiously alternating series of wood zones.—W. E. **Collinge**: A new genus and species of terrestrial Isopoda from British Guiana.—Dr. **Stapf**: Inflorescences of the Carob tree (*Ceratonia siliqua*) representing the several sexual conditions in which the tree occurs. Reference was made to Cavanilles's observations in the Carob groves of Valencia and the work done by Heckel and Schlagdenhauffen on the French Riviera, and by Gennadius in Cyprus. According to these authors most of the apparently female trees, that is, trees with very small subsessile anthers, are in reality hermaphrodite (brachystemonous hermaphrodites in contradistinction from the rare dolichostemonous hermaphrodites). But Dr. Stapf pointed out that no anthers containing pollen could be found in the "brachystemonous" specimens in the Kew Herbarium, in spirit material recently received from the Italian Riviera, and in preparations of such flowers obtained from Cyprus. In spite of Heckel's, Schlagdenhauffen's, and Gennadius's excellent work, there is still some mystery surrounding the pollination of the Carob tree which is certainly worth studying on the spot.

Zoological Society, March 9.—Mr. R. H. Burne, vice-president, in the chair.—R. I. **Pocock**: The feet, perfume-glands, and other external characters of the Viverrinæ. The term Viverrinæ was used by the author in a restricted sense for the typical Civets and Genets referred hitherto to the three genera, Viverra, Viverricula, and Genetta. He pointed out, however, that a new generic term must be introduced for the African Civet (*V. civetta*), which differs from the Oriental species (*V. zibetha*), the type of the genus Viverra, in the presence of a small metatarsal pad, the absence of skin-lobes protecting the claws on the fore-feet, the nakedness of the area of the feet round the plantar pad, the structure of the perfume-gland, etc.—Mary L. **Hett**: New Pentastomids from the lungs of snakes. The snakes from which the material was obtained had died in the society's gardens. There is great difficulty in establishing diagnostic characters for the separation of species in the Pentastomids. Size and number of annulations have generally been used as standards of comparison and they hold good in a certain number of cases; but in many forms both these characters are so variable as to afford no sound basis for classification. This is illustrated by *Porocephalus bifurcatus* and three allied forms which are here described as varieties. They were all obtained from the lungs of snakes from different regions. An average specimen of each form differs from the other varieties in length and number of rings, but intermediate forms occur which almost bridge the gap between them in both particulars. Hence it is difficult to regard them as separate species. If, however, the differences should prove to be of specific value, the four species, together with one other, should certainly be united in a new genus, as they differ from all other Pentastomids and resemble one another in several important particulars.—Reports on the collections made by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea:—G. J. **Arrow**, G. A. K. **Marshall**, and C. J. **Gahan**: Coleoptera.—F. W. **Edwards** and E. E. **Austen**: Diptera.—H. **Campion**: Odonata.—Dr. L. Cognetti de **Martiis**: Vermes.—G. **Arnold** and Dr. C. L. **Boulenger**: The fresh-water Medusa recently discovered in the Limpopo River system. This jelly-fish is referred to the same species (*Limnocnida rhodesiae*, Boulenger) as the form described from a tributary of the Zambesi River in 1912. Species of Limnocnida are now known to occur in the five principal river systems of Africa as well as in the Bombay Presidency of India. The paper contains descriptions of the structure and habits of the jelly-fish, and attention is directed to the occurrence of parasitic Infusorians of the genus Trichodina on both the African species, *L. tanganicae* and *L. rhodesiae*.—F. F. **Laidlaw**: Bornean dragonflies collected on Mount Kina Balu. Two new genera and seven new species were described.

Geological Society, March 10.—Dr. A. Smith Woodward, president, in the chair.—C. **Reid**: The plants of the late Glacial deposits of the Lea Valley. Large collections of plants from the Lea Valley deposits, already described, have been made by Mr. S. H. Warren, Mr. E. T. Newton, and Mr. Wrigley. The localities from which the plants were obtained are Angel Road, Hedge Lane, Ponders End, and Temple Mills. A list from Ponders End has already been given by Dr. Lewis, but the new collections include many unrecorded species, several of which have not previously been noted as British fossils. Although there are slight differences, the collections from all four localities are so similar as to leave no doubt that the deposits are contemporaneous. The whole assemblage points to a very cold climate, though perhaps not quite so cold as that indicated by the Arctic plants found at Hoxne, in Suffolk. Among the more interesting novelties may be mentioned *Armeria arctica*, a species of thrift now confined to Arctic America, although it has also been recorded as a Pleistocene fossil from the continent of Europe by Dr. C. A. Weber.—S. **Smith**: The genus Lonsdaleia and *Dibunophyllum rugosum* (McCoy). The present paper discusses the literature, structural characters and development, descent, classification, and distribution of the corals constituting the genus Lonsdaleia; it includes also a description of *Dibunophyllum rugosum* (McCoy).

Royal Meteorological Society, March 17.—Dr. W. G. **Duffield**: The meteorology of the sun. An account was given of methods and results of spectroscopic and other observations of solar phenomena. Abbot's work on the variability of solar radiation opens up the prospect of further discoveries in connection with solar and terrestrial phenomena, the most important practical problem in the region of physics or meteorology. It is the hope of astronomers that the earth will be completely girdled by observatories which will take part in the international scheme of co-operation in solar research. The promise of such observatories in Australia and New Zealand is welcomed by all interested in the development of solar and terrestrial meteorology.

BOOKS RECEIVED.

Elementary Human Biology. By J. E. Peabody and A. E. Hunt. Pp. xii + 194. (London: Macmillan and Co., Ltd.) 4*s*.

The Chemistry of Paints and Painting. By Sir A. H. Church. Fourth edition. Pp. xx + 388. (London: Seeley, Service, and Co., Ltd.) 7*s*. 6*d*. net.

Elementary Electricity and Magnetism. By W. S.

Franklin and B. MacNutt. Pp. viii+174. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 1.25 dollars net.

Advanced Theory of Electricity and Magnetism. By W. S. Franklin and B. MacNutt. Pp. vii+300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 2 dollars net.

The Mathematical Analysis of Electrical and Optical Wave-Motion on the basis of Maxwell's Equations. By Dr. H. Bateman. Pp. vi+159. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

A Treatise on the Theory of Alternating Currents. By Dr. A. Russell. Vol. i. Second edition. Pp. xiv+534. (Cambridge: At the University Press.) 15*s*. net.

Zoology. By Dr A. E. Shipley and Prof. E. W. MacBride. Third edition. Pp. xx+752. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

The Story of Plant Life in the British Isles. By A. R. Horwood. Vol. iii. Pp. xvi+514. (London: J and A. Churchill.) 6*s*. 6*d*. net.

Explosives: Their Manufacture, Properties, Tests, and History. By A. Marshall. Pp. xv+624. (London: J. and A. Churchill.) 24*s*. net.

Dyestuffs and Coal-Tar Products: Their Chemistry, Manufacture, and Application. By T. Beacall, Dr. F. Challenger, Dr. G. Martin, and Dr. H. J. S. Sand. Pp. vii+156. (London: Crosby Lockwood and Son.) 7*s*. 6*d*. net.

British Birds. By A. Thorburn. In 4 vols. Vol. i. Pp. viii+143. (London: Longmans and Co.) 6*l*. 6*s*. 4 vols.

The Minor Horrors of War. By Dr. A. E. Shipley. Pp. xvii+166. (London: Smith, Elder and Co.) 1*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 25.

ROYAL SOCIETY, at 4.30.—The Production of Growths or Deposits in Meta-stable Inorganic Hydrosols: Prof. B. Moore.—Forms of Growth resembling Living Organisms and their Products slowly deposited from Meta-stable Solutions of Inorganic Colloids: Prof. B. Moore and W. G. Evans.—A Contribution to our Knowledge of the Chemistry of Coat-Colour in Animals and of Dominant and recessive Whiteness: H. Onslow.

ROYAL INSTITUTION, at 3.—The Ground beneath London: Dr. A. Strahan.

CHILD STUDY SOCIETY, at 6.—The Care of the Teeth: C. E. Wallis.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephone Troubles in the Tropics: W. L. Preece.

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—A Contribution to the Theory of Propulsion and the Screw Propeller: F. W. Lanchester.—A Comparison between the Results of Propeller Experiments in Air and Water: A. W. Johns.—Further Model Experiments on the Resistance of Mercantile Ship Forms: The Influence of Length and Prismatic Coefficients on the Resistance of Ships: J. L. Kent.—At 3 p.m.—The Law of Fatigue Applied to Crankshaft Failures: C. E. Stromeyer.—The Effect of Beam on the Speed of Hydro-Aeroplanes: L. Hope.—Notes on the Cross Curves and GZ Curves of Stability: E. F. Spanner.

FRIDAY, MARCH 26.

ROYAL INSTITUTION, at 9.—Experiments in Slow Kathode Rays: Sir J. J. Thomson.

GEOLOGISTS' ASSOCIATION, at 8.—On the Structure of the Eastern Part of the Lake District: J. F. N. Green.

PHYSICAL SOCIETY, at 5.—The Change of Thermal Conductivity with Fusion: Prof. A. W. Porter and F. Simeon.—An Instrument for the Optical Projection and Delineation of Physical Curves, such as Hysteresis, Resonance and Characteristic Curves (with experiments): Prof. J. A. Fleming.—The Stability of Some Liquid Films: Dr. P. Phillips and J. Rose-Innes.—A Demonstration of the Green Flash at the Setting of an Artificial Sun will be given by Prof. A. W. Porter and E. T. Paris.

SATURDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Annual Meeting.—The Dating of Early Human Remains: S. Hazzledine Warren.—Notes on Palæolithic Implements from Wanstead Park: C. H. Butcher.

MONDAY, MARCH 29.

ROYAL SOCIETY OF ARTS, at 8.—House Building: M. H. Baillie Scott.

INSTITUTE OF ACTUARIES, at 5.—Two Notes on Questions of Office-Practice: R. Todhunter.

TUESDAY, MARCH 30.

ROYAL SOCIETY OF ARTS, at 4.30

WEDNESDAY, MARCH 31.

INSTITUTION OF ELECTRICAL ENGINEERS, at 7.45.—Students' Section.—Some Notes on High-tension Overhead Transmission Lines: E. T. Driver.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Estimation of Methyl Alcohol in Presence of Ethyl Alcohol: G. C. Jones.—Note on the Determination of Niobium in presence of Tantalum, and some reactions of Tantalum Compounds: A. G. Levy.—Estimation of Carbon Dioxide in Self-raising Flours and Baking Powder: T. Macara.—Bromine Method of Determining Phenol: W. Versfeld.—A Method for the Determination of Chlorine in Cheese: Miss E. C. V. Cornish and J. Golding.

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THURSDAY, APRIL 1, 1915.

THE DEVELOPMENT OF THE INVERTEBRATES.

Text-book of Embryology. Edited by W. Heape. Vol. i. Invertebrata. By Prof. E. W. MacBride. Pp. xxxii + 692. (London: Macmillan and Co., Ltd., 1914.) Price 25*s*. net.

THE appearance of Balfour's great work on comparative embryology in 1880 marked an epoch in the history of zoology. Since then not only has a vast quantity of new information been acquired, but whole new branches of the study have been developed. For instance, we now have the science of experimental embryology, which aims at discovering the conditions and regulative processes of differentiation and development—a science founded by Roux, Driesch, and others; while to E. B. Wilson and other American observers we owe the study of cell-lineage, whereby the prospect is opened up of being able to trace back homologous organs not merely to germ-layers, but to corresponding individual cells in the early history of the embryo. To give a clear and concise account of these modern researches is indeed a difficult task. Prof. MacBride is the first Englishman to make the attempt, and it may be said at once that he has been, on the whole, most successful.

The descriptions are remarkably lucid, and easy to understand with the help of an abundance of really excellent illustrations. Each chapter deals with a separate group. After a brief introduction, it begins with as complete an account as possible of the whole development of a typical example, from egg to larva, and from larva to adult. Other forms are then briefly compared with the type, and there follows a discussion of the general features of the embryology, of their phylogenetic significance, and of the affinities of the group. There is much to be said for this mode of treatment. The story of the development is continuous, and the reader is presented with a very complete picture of the ontogeny of a representative of each group. At the same time there is some danger that he may not fully realise how much diversity of development there often is among closely allied animals; and that the type chosen may be, and indeed often is, the most specialised. Following the history of normal development, we also find in many chapters an interesting discussion of the results of experimental embryology. Here and there the text is varied with useful notes on the occurrence and habits of larvæ, and on methods of collecting and preserving material.

Such a work is bound to show weak points, and the chapters are certainly of unequal merit. Readers will turn with special interest to the part devoted to Echinoderms, since Prof. MacBride's important researches on these animals are well known. They will not be disappointed, but will find, we think, the best account of the embryology of the Echinoderms yet published in any text-book. On the other hand, certain obscurer groups are altogether omitted, or are scarcely mentioned. Considerations of space may, no doubt, have compelled the author to aim rather at giving a full history of the more important forms than at completeness. But we venture to think that it would have been better to devote more attention especially to organogeny in the earlier chapters, and to have collected the parts dealing with experimental work into a separate volume. For the general questions, which the experiments are designed to elucidate, are far better discussed as a whole than piecemeal in the various chapters. Want of space has also prevented Prof. MacBride from giving any historical account of the subject, from referring in most cases to any but the most recent publications, and from providing a fuller bibliography.

Knowing what difficulties the writer of a text-book has to contend with, it is an ungrateful task to find fault with so excellent a work. Yet some points may be mentioned which might well be improved in a second edition. We doubt whether the reader of the chapter on the Porifera would gather that there takes place in many sponges the remarkable developmental process known as the "inversion of the layers," so well described by Delage, Minchin, and Maas. Since he admits, we believe quite rightly, that the Ectoprocta and Endoprocta are independent phyla "not descended from a common fixed Polyzoon ancestor," why has not the author the courage to separate them, following the example of some of his predecessors? Again, we find the Opisthogoneata and the Progoneata still joined in the artificial group Myriapoda. Such conservatism obscures the issue, and hinders progress. We wonder, also, why he retains the word nephridium, even in inverted commas, for the segmental ducts of Peripatus, derived from the cœlomic wall, and not homologous with the nephridia of the earthworm to which Lankester first gave the name. Indeed, the whole question of the nephridia, their development and homology, seems to be very inadequately treated. Here the author appears to be treading on unfamiliar ground, and to be insufficiently acquainted with the literature on the subject. Even less satisfactory is Prof. MacBride's discussion of the cœlom. Its origin is vaguely referred to the radial enteric chambers of some remote Cœlenterate ancestor. The author appears to forget that these chambers are formed in a fundamentally different way and order, by the ingrowing of mesenterial folds. Moreover, one of the many serious objections to this theory is that it fails utterly to bridge over the gap between the Cœlenterate and the Cœlomate, and leaves quite unexplained the structure of the Platyhelminth and Nemertine. It is just here that the Gonocœle theory has proved so valuable, giving the only intelligible interpretation of the morphology of these lower forms, founded not on vague speculations, but on the comparison of well-established facts in comparative anatomy. This theory, founded and supported by Hatschek, Ed. Meyer, Lang, and many others, Prof. MacBride dismisses with scorn, and the remarkable statement that any vogue it has obtained "is only in consequence of the myopic concentration of attention on the facts of development in a limited number of groups, and the neglect of the facts of development in other groups" (p. 166).

The suggestion made on p. 661 that the diverticula of the gut in the Platyhelmia represent the cœlom takes us back some thirty years to a time before the structure of these animals was understood, besides being in direct opposition to the teaching of cell-lineage so clearly described in this very volume. The determination of the homology of the mesoblast cells in Platyhelminths, Nemertines, Annelids, and Molluscs is surely one of the most important contributions of modern embryology to the morphology of the Invertebrata.

The author is less happy in his phylogenetic speculations than in his descriptions of development. So much is he under the influence of the recapitulation theory that almost all free-swimming larvæ appear to him as scarcely modified ancestral forms. It need scarcely be pointed out that the mere prevalence of a common larval form in one or several groups of animals does not in itself prove that this larva closely resembles the adult common ancestor. It may be taken as good evidence that the ancestor also possessed such a larval stage, and is therefore an indication of the close affinity of the animals concerned. Beyond this it is unsafe to theorise without other evidence from comparative anatomy or palæontology. It should never be forgotten that ancestors were not larvæ, but self-supporting adults capable of reproduction. Prof. MacBride would have done better to follow the example of Sir Ray Lankester, who long ago, when he reconstructed his famous Archi-mollusc, took as his model not the trochosphere nor even the veliger larva, but a creeping animal. If we adopted the author's theories as to the ancestral significance of larval forms, we should have to suppose that a large number of the characters held in common by the various groups have been independently developed, a conclusion for which there would seem to be no justification.

When discussing general questions in a final chapter Prof. MacBride appeals to hormones as affording a rational explanation of the *modus operandi* for the supposed "inheritance of acquired characters." This view is, of course, not new; Delage, Vernon, and Cunningham have in turn supported it. But, quite apart from the evidence of such inheritance, it is difficult to see how these internal secretions could become incorporated into the blastogenic factors of development.

We congratulate both the author and the editor on the production of this handsome text-book. It will doubtless be warmly welcomed by all English-speaking students and teachers of embryology, and take the place it deserves among the standard works on the subject.

E. S. Goodrich.

THE BUTTERFLIES OF AUSTRALIA.

The Butterflies of Australia: a Monograph of the Australian Rhopalocera. By G. A. Waterhouse and G. Lyell. Pp. vi+239+plates. (Sydney: Angus and Robertson; London: Oxford University Press, 1914.) Price 42*s*. net.

The scientific study of the butterflies of Australia is certain to be greatly advanced by the appearance of this admirable work, although it is to be feared that the high price will tend to prevent a very wide circulation. It is obvious, however, that a costly book is implied by the presence of forty-three excellent quarto plates, of which four are coloured. In addition to this abundant and most necessary illustration in plates, the reader is provided with numbers of text figures as well as a valuable map-index of localities. One of the plates is devoted to larvæ and pupæ, one coloured plate to the variations of the Satyrine butterfly *Tisiphone joanna*, the three others to special Satyrinæ, Lycænidæ, and Hesperidæ. The remaining thirty-eight uncoloured plates contain 793 figures, all natural size, of the 332 species recognised by the authors as at present known in Australia.

Especial attention has been given to geographical distribution, and the authors have made a point of examining long series of specimens wherever available. In this work they have received help from many students of the Australian Rhopalocera, while Mr. Waterhouse's extremely fine collection, seen by the present writer during the recent visit of the British Association, has clearly been developed with the object of producing this volume.

The trinominal system of nomenclature, the principles of which are clearly explained in the introduction, is followed by the authors as by most naturalists who have made a special study of geographical distribution. At the same time, new subspecies or geographical races have only been created when plenty of material was available. The authors have wisely deemed it "preferable that a race should continue undetermined rather than the racial characters should be wrongly described or a new race erected on insufficient grounds."

The exigencies of space prevent any detailed discussion or description of the work, but it must be mentioned that the remarkable *Euschemon* is considered as a "Skipper" (Hesperidæ) and not as a moth. This conclusion appears to the present writer to be entirely sound, although the primary division of Lepidoptera into "butterflies" and "moths" is, of course, artificial and merely a matter of convenience.

In addition to the description of the species and the groups to which they belong, occupying nearly the whole of the volume, there is an introductory section with a brief historical account of Australian work and an excellent general description of the Lepidoptera, together with the anatomical features relied upon by the systematist. A concluding section, with "Notes upon Collecting and Collections," complete the work by rendering it a sufficient guide to the beginner.

The keen Australian naturalist is now provided with a foundation upon which to build. The present work will tell him what he is dealing with, and will indicate much of the work that remains to be done. Blank records of food-plants and of larval and pupal stages will suggest, to those interested in breeding, one of the most fascinating of all inquiries. We may hope that the bionomic problems presented by the Australian Lepidoptera, as yet scarcely attacked at all, will now receive attention; that geographical variation, so specially studied by the authors, will forthwith be advanced by the efforts of a band of new observers.

The naturalist living in the cooler parts of Australia need not be discouraged by comparing his species with the grander forms of the tropical north. These latter are for the most part identical with or very closely allied to Papuan species, while his own less magnificent butterflies are characteristic of the great southern continent. At the same time, the resident in northern Queensland has the opportunity of solving complex problems of tropical life with its elaborate inter-relationships—an opportunity of which Mr. F. P. Dodd has taken such great advantage. With the present work as a guide we may look forward to a rapid advance along many lines in our knowledge of the butterflies of Australia.

E. B. P.

PHYSICAL ANTHROPOLOGY.

Lehrbuch der Anthropologie in Systematischer Darstellung. Mit besonderer Berücksichtigung der anthropologischen Methoden für studierende Aerzte und Forschungsreisende. Von Prof. R. Martin. Pp. xvi+1181. (Jena: G. Fischer, 1914.) Price 35 marks.

IN these later years the Anthropological Institute of the University of Zürich has acquired a very high reputation amongst anthropologists. The success of Zürich as a centre of anthropological research and teaching is due to Prof. Rudolf Martin who, these twenty years past, has gathered round him and trained a band of young men, who are now spreading abroad the reputation of the new Swiss school.

In the work under review, Prof. Martin gives a systematic account of twenty years of experience as an expert anthropologist, detailing his methods of measurement, his manner of making records and describing the principles on which his methods are based. His text-book is much more than a technical manual; it is really an encyclopædia of knowledge relating to the size and shape of body in all races of mankind. There was great need for a standard work on physical anthropology; Prof. Martin has supplied that need.

The modern conception of the scope of physical anthropology and the relative importance attached to each of its branches will be made clear by a summary of the contents of Prof. Martin's text-book. The largest section is given to the skull; 422 pages out of a total of 1069 are devoted to the methods and results of craniology. The next important section is that which deals with the living body—its measurements, proportions, pigmentation, growth, etc.; to this subject considerably more than a third of the total book is assigned. A separate section is devoted to a consideration of the skeleton—189 pages. Thus, the major part of this work is devoted to the skull, skeleton, and external characters of the body.

The two opening sections, although condensed—amounting altogether to 102 pages—are both useful and important. These opening sections deal with anthropological methods, particularly with the best means of expressing results in graphic and in mathematical forms. The classification of human races, the relationship of man to other mammalian forms, and the origin and progress of anthropological knowledge are discussed briefly but yet at sufficient length to meet the needs of the average student. A. K.

MONOGRAPHS AND TEXT-BOOKS OF CHEMISTRY.

(1) *Nucleic Acids: their Chemical Properties and Physiological Conduct.* By Prof. W. Jones. Pp. viii+118. (Monographs on Biochemistry.) (London: Longmans, Green and Co., 1914.) Price 3*s.* 6*d.* net.

(2) *The Simpler Natural Bases.* By Prof. G. Barger. Pp. viii+215. (Monographs on Biochemistry.) (London: Longmans, Green and Co., 1914.) Price 6*s.* net.

(3) *The Chemistry of the Radio-Elements.* By Prof. F. Soddy. Second edition. Part i. (London: Longmans, Green and Co., 1914.) Price 4*s.* net.

(4) *Encyclopédie de Science Chimique Appliquée.* Tome v., "Principes d'Analyse et de Synthèse en Chimie organique." By M. Hanriot, Prof. P. Carré, and others. Pp. 795. (Paris et Liège: Ch. Béranger, 1914.)

(5) *The Principles of Inorganic Chemistry.* By W. Ostwald. Translated with the author's sanction by Prof. A. Findlay. Fourth edition. Pp. xxxiii+836. (London: Macmillan and Co., Ltd., 1914.) Price 18*s.* net.

(6) *The Chemistry of Cyanogen Compounds and their Manufacture and Estimation.* By H. E. Williams. Pp. viii+423. (London: J. and A. Churchill, 1915.) Price 10*s.* 6*d.* net.

(7) *Advanced Inorganic Chemistry.* By P. W. Oscroft. Pp. viii+504. (London: G. Bell and Sons, Ltd., 1915.) Price 5*s.* net.

(8) *Preparations and Exercises in Inorganic Chemistry.* By W. Lowson. Pp. vii+128. (London: Methuen and Co., Ltd., 1914.) Price 2*s.* 6*d.*

(9) *A Manual of Chemistry: Theoretical and Practical, Inorganic and Organic.* Adapted to the requirements of students of medicine. By Dr. A. P. Luff and H. C. H. Candy. Pp. xix+660. Fifth edition. (London: Cassell and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

(1) and (2) THE subject of biochemistry, like many other branches of knowledge, has already extended to dimensions which effectively prevent any one author from doing justice to more than a part of the subject. Under these conditions it has been usual to witness the production of a text-book in which a general editor has distributed the work amongst a number of colleagues. The two monographs now under review are excellent examples of a better method of treatment. The publication of a series of smaller monographs provides just that flexibility which is required by a rapidly-growing subject; topics which are not yet ripe for description in a text-book can be held over to await further development, whilst individual sections can be revised and brought up to date without rendering obsolete a whole edition of many volumes.

Prof. Jones's monograph on the "Nucleic Acids" provides a fascinating story both for chemists and for physiologists, and affords a revelation of the amount of definite knowledge that is now coming into existence in reference to the chemical composition of plant and animal bodies.

It is very interesting to watch what materials are used in nature for the building up of living tissues. In the present case one of the most important sugars has been proved to be *d*-ribose (hitherto not known to chemists), whilst the bases belong to the pyrimidine series or are related to uric acid; the formula for the last substance is written in an unfamiliar form, with a hexagonal nucleus, which suggests a real analogy with the bases of the indol and skatol series. The inclusion of a bibliography covering sixteen pages of text will show how extensive is the literature on which this compact volume is based.

Prof. Barger's monograph covers a more extensive field, and is based on a bibliography which extends over 44 pages of text. These simpler bases are related in some ways to the alkaloids. They are distributed much more widely, but must be extracted by different methods. For this reason they were not recognised until a much later date; but, once identified, they are often capable of synthetical preparation on a large scale. Few things, in the recent growth of biochemistry, are more remarkable than the proof that has been given of the simple chemical character of many substances of intense physiological activity. The most striking case is that of adrenaline, but there is reason to believe that other internal secretions owe their activity to bases of comparatively small molecular weight. If this should be the case, the study of these bases may prove to be of even greater importance than that of the amino-acids which bulk so largely in the structure of the proteins.

(3) The appearance of a second edition of Prof. Soddy's monograph on the radio-elements is an indication of the rapid growth of the subject with which it deals. Many new members have been added to the disintegration-series, but there is reason to think that something approaching completeness has now been attained, and that further study will be devoted mainly towards an increased

knowledge of these elusive elements, some forty of which are crowded into ten places of the conventional periodic classification.

(4) The French book on analysis and synthesis is the fifth volume of an Encyclopædia of Applied Chemistry. It includes five sections on "Organic Analysis," by M. Hanriot; "Pharmaceutical Products," by P. Carré; "Synthesis of Colouring Matters," by A. Sergewetz; "Production of Perfumes," by E. Charabot; "Saponification," by A. Hébert. It is therefore in reality a series of five monographs, bound together in one volume and grouped under a convenient general title. It forms a companion to a similar volume on the theory and practice of mineral analysis, but might with advantage have been issued in separate parts, as it is unlikely that many workers would attempt to cover the wide field included in this volume.

(5) Prof. Ostwald's "Principles," of which a fourth edition is now published, is an inorganic chemistry written from the point of view of the physical chemist. The ionic hypothesis occupies a place of honour throughout the volume. In the new edition a final chapter on the radio-active elements contains a somewhat full account of the three chief disintegration-series of radio-elements.

(6) Mr. Williams' book on the cyanogen compounds contains a detailed description of this important series of compounds, arranged somewhat in the manner of a dictionary. Thus under the heading of "Thiocyanates," details are given as to the composition and properties of thirty-two simple salts and a far larger number of double salts. The author has made a number of experiments himself, the results of which are now described for the first time, the "petty restrictions" and "stereotyped methods" of the scientific societies having prevented him from publishing them through the usual channels. Fortunately, he has been able to avail himself freely of the work of others who have faced these obstacles. The book is therefore generously supplied with references to original literature, which render it a valuable guide to the subject with which it deals.

(7) Mr. Oscroft's book suffers from an unfortunate title. Intended primarily for senior classes of boys, it is described in the title as an "advanced inorganic chemistry," and in the text as a "Chemistry for advanced students." Such a description is misleading in the case of a book which devotes only one page to the Periodic Law, four pages to radio-activity, and five pages to spectrum analysis. Apart from this obvious error the book is a good example of the class of school text-books to which it really belongs. The author is in touch with the historical treatment, which is now becoming so important in the teaching of elementary chemistry, and promises also to effect, on the theoretical side, an improvement comparable with that which has resulted from the introduction in the laboratory of experiments based largely on the classical work of Scheele, Cavendish, and Priestley. The illustrations are scarcely equal to the standard of the text, and are not improved by labelling the gases as H, N, O, etc., in direct defiance of their recognised molecular formulæ. The formulæ given on p. 223 for persulphuric acid should be H_2SO_5 (monobasic) and $H_2S_2O_8$ (dibasic), and the preparation on p. 242, described and indexed under persulphuric acid, refers obviously to pyrosulphuric acid.

(8) The instructions used in the chemical laboratories at Leeds in the teaching of elementary students have been expanded by Mr. Lowson into a small volume intended primarily for local use, but likely to prove acceptable in other laboratories where similar work has to be carried out. The book consists mainly of simple preparations, which are described in detail in order to economise the time of the teacher and to enable him to accommodate the course to the varying abilities of different students. Theoretical questions suggested by the experiments are, however, referred to from time to time, and a large number of additional exercises are provided in connection with the different preparations.

(9) Luff and Candy's "Chemistry for Students of Medicine" shows a marked improvement in each successive edition. The condensation of the whole of the chemical theory, including the periodic classification of the elements, into one preliminary section does not provide a practicable basis for actual class-teaching; but it may well prove convenient to a student who wishes to revise what he has learnt in a course of lectures arranged on a gentler gradient. Historical references are more frequent than in the earlier editions, as the author has found that these interest the student, and also enable him to trace the evolution of the fundamental principles of chemistry, and thus appreciate their full significance. T. M. L.

OUR BOOKSHELF.

The Germ-cell Cycle in Animals. By Prof. R. W. Hegner. Pp. x + 346. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 7s. 6d. net.

In this interesting book Prof. Hegner gives a very complete and clear account of the origin, structure, and continuity from generation to generation of the reproductive cells of the Metazoa. Owen appears to have been the first clearly to point out that the fertilised ovum gives rise to two kinds of cells: the first destined to form the differentiated tissues of the new individual, the second remaining relatively unchanged and destined to propagate the race. Recent investigations, to which the author has made valuable contributions, tend to show that the distinction, once established, is irrevocable, and that germ-cells are derived from pre-existing germ-cells in an unbroken stream—the germ-track. Modern methods have enabled investigators to trace the appearance of germ-cells to earlier and earlier stages in development, thanks to certain distinctive characters of the cytoplasm or nucleus. The name keim-bahn determinants, or germ-track determinants, as we should prefer to call them, is given to such recognisable features in the cells. Although in some animals, such as Ascaris and Sagitta, the germ-cells have been traced back to the very early embryo consisting of only a few cells, the complete segregation of the germ-forming substance has not yet been observed in the first cleavage of the egg into two cells.

Having given an excellent review of the evidence on this subject, Prof. Hegner proceeds to discuss the significance of the germ-track determinants, the chromosomes and mitochondria of germ-cells, the determinants of sex, and kindred questions. No doubt the most interesting problems relate to the possible identification of factors which determine the fate of cells—whether they will become germ-cells or body-cells, ova or spermatozoa, and also the fate of individuals—whether they will become males, females, or hermaphrodites. Through no fault of the author these problems are left unsolved. But concerning the germ-plasm theory itself he is confident that it rests on a firm basis, while inclined to believe that the germ-plasm resides not in the nucleus or chromosomes alone, but also in the cytoplasm.

Quain's Elements of Anatomy. Eleventh edition. Vol. iv, Part 1. *Osteology and Arthrology*. By Dr. T. H. Bryce. Pp. viii + 329. (London: Longmans, Green and Co., 1915.) Price 12*s*. 6*d*. net.

IN the latest (eleventh) edition of "Quain's Anatomy"—a standard work—there have been several alterations, one of them being the inclusion of the chapters giving a descriptive account of the joints with the volume devoted to the skeleton of the human body. Part 1 of Vol. iv., which has just appeared under the editorship of Prof. T. H. Bryce, thus gives a systematic account of the bones and joints of the human body. We are very glad to note that the editor gives a fairly full list of the more important of recent publications—an essential feature of a standard work. Prof. Bryce has done well in retaining the excellent drawings which Mr. D. Gunn, Dr. T. W. P. Lawrence, and Prof. G. D. Thane contributed to the last edition, and has improved the chapters dealing with the joints by the use of new coloured plates prepared by Mr. A. K. Maxwell. Another decided improvement is the introduction of an account of the development of the various parts of the skeleton in the chapters devoted to descriptions of the bones. The investigations of Prof. Fawcett and of Dr. Alex. Low have been incorporated in the new text. Altogether, this volume of the new "Quain" will be welcomed by teachers and students of anatomy.

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 Rules of Zoological Nomenclature.

As one of the British members on the International Commission for Zoological Nomenclature, I have frequently been asked where copies of the rules as revised and adopted at the Monaco Congress are to be obtained in separate form. May I therefore use your widely-read columns to inform zoologists (including palæontologists) that a translation into French, the official language, has been made by Prof. R. Blanchard, in agreement with the secretary to the Commission, and has been published in the *Revue critique de Paléozoologie*, edited by Mr. Maurice Cossmann, 110 Faubourg Poissonnière, Paris X? Reprints may be purchased, at a price of 4*s*., from Messrs. Dulau and Co., Ltd., 37 Soho Square, London, W. Mr. Cossmann has added some useful notes, especially from the point of view of the palæontologist, but these, it should be remembered, have no authority from the Congress or the Commission.

F. A. BATHER.

Natural History Museum, South Kensington, S.W., March 30.

The Preparation of Anhydrous Solids.

THE following method may perhaps be of use to chemists and biologists who are concerned in the preparation of solid compounds in the anhydrous state for analysis, or in obtaining anhydrous tissues for moisture determinations, etc. It consists in utilising Prof. S. Young's process for the purification of alcohol from all water by distilling it through his evaporator still-head, with the previous addition of a suitable quantity of benzene.

The tissue or compound to be dehydrated is placed in the distillation flask with alcohol and benzene in the proper proportions. When all the turbid ternary mixture of constant boiling point has been removed, by distillation from a water-bath, the remaining mixture of alcohol and benzene may be rapidly distilled away, and the last traces can be removed in a vacuum desiccator. By adjusting the quantities either alcohol or benzene can be obtained as the residual liquid, and the complete removal of either of them is far more readily effected than is that of water owing to their lower boiling points and greater volatility.

The method avoids all risk of oxidation, a source of serious error when plant tissues are dried at 100° C. in air. It appears that this procedure can be adopted for quantitative determinations in many cases, and may throw light upon the existence of water as "water of crystallisation" or as "water of constitution." These points are at present being studied by Miss E. G. Wilson and the writer.

W. R. G. ATKINS.

University Chemical Laboratory, Trinity College, Dublin.

THE WAR AND BRITISH CHEMICAL INDUSTRY.

OWING to the urgency of the aniline dye question and the discussion which has been taking place on the Government scheme, it has been thought expedient to issue part iv. of a memorandum dealing with the entire question of the "War and British Economic Policy." It is published by Messrs. P. S. King and Son, of Westminster, and a brief summary of it is given in the *Chemical News* of February 26. British industries use annually dyes to the value of nearly 2,250,000*l.*, of which about 1,750,000*l.* come from Germany, about 150,000*l.* from Switzerland, and only about 200,000*l.* are of British home production. Aniline dyes constitute an indispensable material in many branches of the textile, leather, paper, and other industries, and the annual value of the goods in which they are an essential or important part is estimated at 200,000,000*l.*

The opinions of a large number of firms interested in the use or manufacture of aniline dyes are given in the memorandum in question, and emphasis is laid on the fact that the dependence upon German supplies is so great that the present capacity of British dye works is totally inadequate to fill the gap. During the past few weeks the Government scheme has formed the subject of numerous articles and letters to the Press, and a brief review may here be given of these, so far as they deal with the general question of the relationship between science and industry in this country, and ignoring all problems of a political nature, such as the question of the necessity for a protective tariff for the proposed new industry.

Prof. Armstrong, in a letter to the *Morning Post* of February 27, after considering the report of the debate on the Government dye scheme in the House of Commons, concludes that the "situation is an almost hopeless one owing to the lamentable ignorance of our public men of matters scientific." He illustrates this want of knowledge by a criticism of Mr. Runciman's recent pronouncement that in organising the new scheme the Government "had at their elbows two, at least, of the greatest chemists of Europe," a description which, it is contended, will "scarcely pass muster."

> If the production of dyes is to be taken in hand seriously, and the foundation laid of a permanent industry, men must be chosen to manage the enterprise who are as able as was my dear old friend, now deceased, Dr. H. Caro, who played so great a part in the development of the Badische Anilin Company, or as his eminent successor, Prof. Bernthsen is, or as is Prof. Duisberg, who has brought the Bayer Company to its present proud position, and now dominates the whole industry. . . . We have in our ranks men of their type who would be immediately available. But apparently the advisers of the Government want subordinate intellects, not leaders.

Dr. M. O. Forster, in a characteristically ironical letter to the same journal, points out that the establishment of an indigenous dye industry "is, has been, and ever will be as much a question of education as of trade. Education of legislators, Government officials, manufacturers, and merchants." It was to have been wished that before taking any steps towards organising the new scheme, every member of the Cabinet, together with the other Ministers, "could have been transferred bodily to Ludwigshafen and personally conducted through the Badische Anilin- und Soda-Fabrik." Dr. Forster depicts with considerable humour the astonishment that Mr. Runciman and the others might have expressed at the organisation and laboratories of this firm, and especially on finding some actual chemists on the directorate.

Several columns are devoted by the *Financier* of February 12, 23, and March 12 to interviews with Mr. W. P. Dreaper, who, as chemist to the Silk Association, speaks with some authority on the practical side of the question. Mr. Dreaper also most strongly emphasises the necessity that the board of the proposed company should contain a scientific representation, and the absolute importance of securing the best scientific knowledge which is available. He protests against the policy of training chemists of the "second class," of which Mr. Runciman seems to consider that we have an insufficient supply, and against the general lack of understanding which exists amongst manufacturers as to what a chemist is "owing to the demand that has sprung up in certain directions for the 70*l.* per annum variety."

The lack of appreciation in this country of the services of the chemist and the absolute ignorance on the part of the Government of what remuneration should be given him is admirably illustrated by the letter of Sir William Tilden in the *Chemical News* of February 26, protesting against the salary offered by the Royal Arsenal, Woolwich, to assistant chemists in the inspection department. At a time when the nation is spending 1,250,000*l.*, and will soon be spending 1,750,000*l.*, per diem on maintaining our army in the field, the utmost that the War Office can afford to give a chemist who has "had a thorough training in inorganic and organic chemistry," and is "a university graduate or member of the Institute of Chemistry," is the sum of 2*l.* 0*s.* 6*d.* per week! Such an advertisement "gives one to think," and is, indeed, a striking object lesson of the fact which Prof. Armstrong deplores—"we have had no public use for science in our country, and we are blind to our needs and as to our opportunities."

The whole question of the utilisation of science in industry is indeed closely wrapped up with that of the miserably insufficient remuneration given in the majority of cases to science and scientific workers, which Sir Ronald Ross has so strongly emphasised in recent numbers of *Science Progress*. So long as the prospects of the young chemist and the remuneration that he receives are of the order indicated in the above advertisement there is little hope of developing in this country industries that require the services of large numbers of highly-trained scientific workers.

It is interesting to find a politician like Mr. L. G. Chiozza Money, M.P., emphasising the same lesson in an article in the March *Fortnightly Review* on "The War and British Industry." Mr. Money comments that "we have been content to leave the development of many old industries and the establishment of many new industries to foreign hands," owing to our "normal" disregard of science.

Let us not deceive ourselves into believing that "science" or "chemistry" affects a limited number of subsidiary industries. There is no industry in the world, from building construction to coke-making, from artillery construction to the making of explosives, from dyeing to leather tanning . . . which has not been in recent years turned inside out by science and invention. We have been content in too many matters to let the world go by us.

Even in the matter of preparation for war Mr. Money, quoting from the address delivered before the Mathematical Association on January 9 by Sir George Greenhill (see NATURE, January 21, p. 573), gives a melancholy contrast between the conditions under which German and British artillery officers have been trained in their science at the Military Technical Academy of Berlin and at Woolwich.

The neglect of science in industry and in public affairs, which is characteristic of this country, culminated in the prospectus of British Dyes (Limited), on the board of which science is entirely unrepresented. The opinions of Sir Henry Roscoe and Sir William Ramsay on the scheme, expressed in the columns of the *Times*, have already been given in NATURE (March 11, p. 41), whilst Prof. Armstrong, in the *Morning Post* (March 13), considers that "our fate as makers of dyes is sealed." The failure of the scheme to attract sufficient capital from investors to justify the directors of the company in proceeding to allotment was referred to last week (p. 94). A meeting of representatives of the textile and dyeing trades was held at Manchester on March 24 to consider the position, and a resolution was adopted in favour of proceeding with the company if certain modifications were made in the business part of the programme. There is no doubt as to the national necessity for such work as the Government scheme is intended to promote, but to expect that a company without a single industrial chemist upon its board of directors will be able to compete with the highly organised coal-tar colour industry of Germany is to show complete want of understanding of the scientific problems which must be faced if permanent success is to be assured.

How little Germany fears competition in this field in the future from English manufacturers, even though aided by the resources of the State, can be gathered from an admirable article by Prof. O. N. Witt in the *Chemiker Zeitung* for February 13. In this article are given the real reasons why Germany has been able to outstrip all competition and to secure practically a monopoly, and why the foundations of the industry are so solidly based that the prospects of the British scheme having anything like a permanent success seem altogether illusory. It must be remembered that the German chemical industry (with one or two exceptions) has never received any protection whatever from tariffs. How futile such protection as that afforded by patent laws can be in comparison with the results obtained by the organisation of science in the service of industry is emphasised by a report to Congress, which is reprinted in the *Chemical News* of March 5. In the United States a 30 per cent. duty on some coal-tar dyes for more than thirty years has not produced a real coal-tar dye industry. Germany, on the other hand, has succeeded because she has placed science on a sound business footing, of which the fair remuneration of the scientific worker has been a striking feature. The part played by the German banks, often with men of considerable scientific attainments on their boards, in developing German industry is emphasised by Mr. W. P. Dreaper in an article on Industrial Research in the *Financier* of March 12.

Germany, in short, has succeeded in the past because she deserved to succeed. Not only has she organised scientific effort on the manufacturing side, but she has organised equally effectively her commercial relations with foreign countries. This side of the question, which has played no small part in attaining the final result, is dealt with in the current *Bulletin* of the Société d'Encouragement (vol. cxxii., p. 33), by M. Lindet, who gives as an example an account of the methods adopted by Germany in Rumania.

The Germans present to the Rumanians objects specially manufactured to satisfy the local requirements, sold at a price which is lower than ours because they are manufactured more cheaply and because they bear lower charges for transport. The German and Austrian merchants and manufacturers interested in Rumanian business have formed a syndicate with its representative at Bucharest. They obtain in this way facilities for transport in common which we do not possess. They have at Bucharest banks which allow long-date credits, and they have representatives and travellers who without intermission pursue their clients. They advertise widely, and have inaugurated at Bucharest a museum of their goods.

It is an organisation of this kind, highly developed on both the manufacturing and commercial sides that we have to prepare to face in the future, after the war has ended and Germany is left free to resume her usual activities.

DR. A. S. LEA, F.R.S.

THE ranks of those who took part in founding the Cambridge Physiology School grows thin. But a few months ago we recorded the death of Dr. Gaskell. We have now to record the death, on March 23, of Dr. Arthur Sheridan Lea at sixty-one years of age.

Lea entered Trinity College, Cambridge, in 1872, he became Foundation Scholar of the College, and in 1875 he took a First Class in the

Natural Sciences Tripos. His bias was to the chemical side of physiological problems, and, in consequence, on Foster's advice, he began research with Kühne at Heidelberg. Kühne combined in a rather unusual manner the study of physiological chemistry with that of histology, and Lea's work with him developed, as it chanced, mainly on histological lines. Kühne and Lea were the first to observe satisfactorily with the microscope the changes taking place in a living gland—the pancreas—with intact circulation, and to note the special vascular supply of the Islets of Langerhans. One of the figures illustrating their paper is given to this day in most text-books of histology and physiology.

Lea, after his return to Cambridge, specialised in physiological chemistry though he gave instruction to pupils in the whole range of physiology, and to him was due the development in the Cambridge laboratory of advanced teaching in this subject. In the successive editions of Foster's "Text-book of Physiology," Lea wrote the part dealing with physiological chemistry, and in the fifth edition (1892) this part, revised and enlarged, appeared as a separate volume entitled "The Chemical Basis of the Animal Body." His research work was chiefly on the chemical changes in food during digestion, and on the action of rennet and fibrin ferments.

Lea's first post was that of demonstrator of physiology for Dr. Foster. In 1881 he became director of medical studies and assistant lecturer at Gonville and Caius College. In 1885 he was elected fellow of the college, and soon after became bursar. He was appointed university lecturer in 1884. His career in the university and in science was cut short by the development of a spinal disease—signs of which had long been present—making walking at first difficult and later impossible. None of his friends can forget the astonishing fortitude with which Lea met this shattering of his chief interests. He had always led an active outdoor life; he had cruised about the coasts in a yacht whenever opportunity offered; he was Captain in the Cambridge Volunteers, had taken special courses of instruction at Aldershot, and was a good rifle shot. Since he could no longer carry on these pursuits, nor continue his research in the laboratory, he decided after a time to break entirely with the old life. He left Cambridge and settled at Sidcup in Kent.

Rarely then or later did Lea rail at fate. He put on a cheerful countenance, and made the best of what was left him. He kept in touch with his old friends, revised the proofs of their books as occasion offered, and occasionally made small pieces of apparatus for them with the mechanically-driven lathe which served to keep up the cunning of his hands. Before leaving Cambridge he had married, and had one son. In a letter written shortly before he died, Lea expressed pleasure that his son had volunteered for the Army and was serving in the trenches. In this as in other matters he kept his private anxieties to himself.

J. N. L.

PROF. A. A. W. HUBRECHT.

The death of Prof. Hubrecht at his residence in Utrecht on March 21, in his sixty-fifth year, removes another link between the zoology of the present day and the zoology of what may be called the great epoch of Huxley and Balfour. His earlier work dates back to 1874, and was of an anatomical character; it was only in the later part of his career that he devoted himself to embryology, and advocated views which led to lively controversy, and were provocative of good work, both on his own part and on the part of those who opposed him.

Speaking broadly, Hubrecht's name will survive as associated with thoroughly sound work and with the elucidation of a large number of most important new facts, even if the deductions which he drew from them no longer find favour with zoologists. So far, indeed, as theories are concerned, Hubrecht's mind continued to reflect the mental attitude of the zoological world in which his youth was passed; it was, indeed, a time of the "faith that moves mountains." Ardent naturalists were applying the Darwinian doctrine of evolution to every part of the animal kingdom; with the enthusiasm of pioneers they were tackling the most obscure and difficult problems of the natural relationships of animals; the deep abysses which separate different phyla of the animal kingdom were traversed by their soaring imagination, for were not the powers of variation limitless? and did not the principle of "change of function" enunciated by Dohrn authorise one to homologise any organ of any animal with any organ of any other animal to which it bore the slightest resemblance? So Hubrecht, to whom we owe the first thoroughly satisfactory account of the anatomy of the Nemertine worms, was convinced that Vertebrata were descended from a Nemertine worm, and that the Nemertine proboscis represented the Vertebrate notochord.

In his later years Hubrecht devoted himself principally to mammalian embryology, and made a series of most valuable observations on the relations between placenta and young in the eutherian mammals. He was led by these observations to a theory of the origin of mammalia, which has not been borne out by the work of other embryologists or by palæontologists. He supposed that the higher mammalia were directly descended from amphibia, and that the monotremata, the anatomy and embryology of which betrays in an unmistakable manner their reptilian affinities, were secondarily modified forms. Here, again, Hubrecht's firm faith carried him over all difficulties. These remarks are not intended as any disparagement of the methods of comparative anatomy or embryology, but are merely designed to emphasise the fact that in these, as in all other sciences, sound inductions are only possible on the basis of an immense accumulation of facts. Modern zoologists addicted to Mendelism would do well to remember that "of making many factors there is no end, and formulæ are a weariness to the flesh."

Hubrecht was a firm friend of England and a constant visitor at scientific meetings here; he could speak English like a native, and his death will be felt as a personal loss by a large circle of friends in this country. E. W. M.

NOTES.

The following resolution of the council of the Royal Geographical Society has been accepted by the fellows of the Society: "The council, having become aware that Sir Sven Hedin, K.C.I.E., a subject of a neutral State, has identified himself with the King's enemies by his actions and published statements, orders that his name be removed from the list of honorary corresponding members of the society." Dr. Sven Hedin has also been excluded from the Russian Imperial Geographical Society.

The council of the Royal Geographical Society has made the following awards of medals and other prizes to be presented at the anniversary meeting on May 17: Founder's Medal to Sir Douglas Mawson for his conduct of the Australian Antarctic Expedition of 1911–14; Patron's Medal to Dr. Filippo de Filippi for his expedition to the Karakoram and Eastern Turkestan in 1913–14; Victoria Research Medal to Dr. Hugh Robert Mill for geographical research extending over many years; Murchison Award to Captain J. K. Davis, who commanded the S.Y. *Aurora* during the time of the Australian Antarctic Expedition; Back Grant to Mr. C. W. Hobley for his contributions to the geology and ethnology of British East Africa; Cuthbert Peek Grant to Mr. A. Grant Ogilvie for his work in geographical investigation and research; Gill Memorial to Colonel Hon. C. G. Bruce for explorations in the Himalayas.

The annual general meeting of the Chemical Society was held at Burlington House on Thursday, March 25. The Longstaff medal for 1915 was presented to Dr. M. O. Forster, and the retiring president, Prof. W. H. Perkin, then delivered his presidential address on "The position of the organic chemical industry," an abstract of which appears elsewhere in this issue. A vote of thanks to the president was proposed by Prof. H. E. Armstrong and seconded by Sir William Tilden. The new officers and members of council elected were:—*President,* Dr. Alexander Scott; *Vice-Presidents,* Prof. F. R. Japp and Prof. R. Threlfall; *Treasurer,* Dr. M. O. Forster; *Ordinary Members of Council,* Mr. D. L. Chapman, Prof. F. G. Donnan, Mr. W. Macnab, and Dr. J. F. Thorpe.

The sixty-eighth annual meeting of the Palæontographical Society was held in the rooms of the Geological Society, Burlington House, on March 26, Dr. Henry Woodward, president, in the chair. The report stated that most of the authors for whom space had been reserved in the annual volume, had failed to contribute owing to the circumstances of the war, and an instalment only of Mr. F. W. Harmer's "Monograph of Pliocene Mollusca" would form the issue for 1914. Messrs. John Hopkinson, Clement Reid, S. Hazzledine Warren, and Henry Woods were elected new members of council. Dr. Henry Woodward was re-elected president, and Mr. R. S. Herries and Dr. A. Smith Woodward were re-elected treasurer and secretary respectively.

The seventieth annual general meeting of the Ray Society was held on March 25, the president, Prof. McIntosh, in the chair. The report for 1914 stated that the number of members had increased and the finances were satisfactory, but a diminution of income was to be expected this year owing to the loss of German and Austrian subscribers on account of the war. For 1914 the "British Marine Annelids," vol. iii., part 1, by the president, had been issued, and for 1915 two volumes were in preparation: the "British Fresh-water Rhizopoda," vol. iii., containing the filose Conchulina, by G. H. Wailes, and the "Principles of Vegetable Teratology," vol. i., containing non-vascular plants and the root, stem, and leaves of vascular plants, by W. C. Worsdell. Prof. W. C. McIntosh was re-elected president, Dr. F. Du Cane Godman treasurer, and Mr. John Hopkinson secretary.

We notice with regret the announcement of the death on March 27 of Mr. J. J. Beringer, associate of the Royal School of Mines, and principal of the School of Metalliferous Mining, Camborne, Cornwall

The death is announced of Prof. F. A. Sherman, professor of mathematics at Dartmouth College, New Hampshire, from 1871 until his retirement as professor emeritus in 1911. Prof. Sherman died on February 25 in his seventy-fourth year.

We learn from *Science* that the Rockefeller Institute for Medical Research has made a grant of 4000*l.* to be used under the institute's direction to further medical research work under war conditions, and is equipping Dr. Carrel's new hospital in France with apparatus for research work in pathology, bacteriology, and surgery.

The death is announced, in his seventy-seventh year, of the Rev. Dr. S. J. Coffin, professor of astronomy since 1873 at Lafayette College, Pennsylvania, in which institution he also occupied the chair of mathematics from 1876 to 1886. He was the author of a treatise on conic sections, and had revised "The Winds of the Globe," by his father, Prof. J. H. Coffin.

The *Times* correspondent at Ottawa states that in the Canadian House of Commons on March 27 Mr. Hazen, Minister of Marine, expressed the opinion that Mr. Stefansson, the Canadian explorer, had been lost with his two companions. The Government, he said, is doing everything of a practicable nature to find the missing men, and three steamers now in the Arctic will set out to the rescue of the expedition as soon as the ice breaks up in the spring.

The American Association of Immunologists will hold its annual meeting at Washington on May 10 next, under the presidency of Dr. G. B. Webb, of Colorado Springs. The association was founded in 1913 for the purpose of bringing together the medical men of the United States and Canada who are engaged in the scientific study of immunity and bacterial therapy; to study the problems of immunology; and to promote scientific research in this department; to spread a correct knowledge of vaccine therapy and immunology among general medical practitioners.

The Board of Agriculture and Fisheries announces that with a view of obtaining further information on their growth, migrations, and general life-history, a number of salmon and sea trout have been marked by means of a ring or wire, with or without a label or tag attached. Rewards will be paid for all such marks returned to the Board, with or without the fish, with information as to the date, time, place, and method of capture. When the entire fish is not sent full particulars of its weight, length, sex, and condition should also be given, and a portion of the skin or flesh of the fish to which the mark is fixed should be cut out. Postage and carriage need not be prepaid, and parcels and letters should be addressed to the Board at 43 Parliament Street, London, S.W.

Prof. H. Robinson, who occupied the chair of civil engineering at King's College, London, from 1880 to 1902, died on March 24, at seventy-eight years of age. From a short obituary notice in the *Times* we learn that Prof. Robinson had charge of many important works, including railways, water supply, sewerage, and electric lighting, an example of the latter being the successful installation at St. Pancras. He engineered the first public hydraulic power scheme in this country at Hull, and took an active part in promoting the distribution of energy in other towns by hydraulic power, compressed air, and electricity. Prof. Robinson was a fellow of King's College, of the Surveyors' Institution, and of the Sanitary Institute, and a past-president of the Society of Engineers.

We notice with much regret the announcement of the death, on March 23, at fifty-three years of age, of Dr. S. G. Rawson, principal of the Battersea Polytechnic, London. Dr. Rawson was educated at Charterhouse School, the Royal College of Science, University College, London, and University College, Liverpool. He afterwards became lecturer in chemistry at University College, Liverpool, and in 1895 he was appointed principal of the Technical College, Huddersfield. In 1903 he was appointed director of education to the Worcestershire County Council, and in September, 1907, he became principal of the Battersea Polytechnic. Dr. Rawson was a doctor of science of the University of London, an associate of the Royal College of Science, fellow of the Institute of Chemistry and of the Chemical Society, and, since January, 1914, was chairman of the council of the Association of Technical Institutions.

We regret to announce the death of Mr. James Kearney, who for the last thirteen years has been inspector in charge of the photo-engraving section of the Egyptian Survey Department. He was originally in the Royal Engineers, and accompanied Sir G. Graham's expeditionary force to the Sudan in 1885 as photographic expert. He was then for several years attached to the Solar Physics Committee at South Kensington, and will be remembered by many old students of the Royal College of Science, London. In 1893 he went to West Africa with the British Eclipse Expedition as expert photographer, and again in 1906 he was with the party who observed the solar eclipse at Aswan. During this period he several times received the thanks of the Royal Society. From 1893 to 1902 he was one of the instructors at the School of Military Engineering at Chatham, which he left to go to Egypt. His wide experience of his subject and originality have largely influenced the development of the reproduction of maps by the Egyptian Survey Department, and practically all their maps now are reproduced by the photo-metal process.

The following are among the arrangements for lectures at the Royal Institution after Easter:—"The Animal Spirits," Prof. C. S. Sherrington; "Advances in the Study of Radio-active Bodies," Prof. F. Soddy; "The Evolution of Steel: Influence on Civilisation," Prof. J. O. Arnold; "The System of the Stars: (1) Star Colour and its Significance; (2) The Stellar System in Motion," Prof. A. S. Eddington; Advances in General Physics," Dr. A. W. Porter; "The Movements and Activities of Plants," Prof. V. H. Blackman; "Method of Presenting Character in Biography and Fiction," Wilfrid Ward; "Modern Artillery," Lieut.-Col. A. G. Hadcock; "Photo-electricity" (the Tyndall Lectures), Prof. J. A. Fleming; "Colouring Matters of the Organic World: (1) Colouring Matters of Nature; (2) Dyes, the Creation of the Chemist," Dr. M. O. Forster. The Friday evening discourses will begin on April 16. Mr. Stephen Graham will deal with "The Russian Idea" and Major P. S. Lelean with "Military Hygiene at the War"; they will be followed by Canon Pearce, Sir John Jackson, Sir Ernest Rutherford, Dr. H. Walford Davies, Profs. F. G. Donnan and O. W. Richardson, and Mr. Edward Heron-Allen.

It is an axiom in business that to be successful the merchant must provide what the public wants. He may try to educate the public by advertisement and other means, but it is the public demand alone that regulates the quality of the supply. The population of this country demands a white loaf of light texture made from the finest portion of the wheat berry, and bakers and millers have made it their business to supply this want. Even at the height of the standard bread boom it is stated that the demand for this article did not reach 5 per cent. of the total. Whether the public taste is the most satisfactory on scientific grounds is possibly open to question; the subject was discussed in an article in these columns on January 7. In the opinion of nearly everyone qualified to judge, our bread is good enough in quality, and the fact remains that the public will take no other. The Bread and Food Reform League holds the contrary view, and recently presented a memorial to the President of the Local Government Board. The *Times* of March 26 reports the presentation of this memorial under the heading, "A Notable Protest." The list of signatories contains a number of notable names, but those of experts who can speak with authority upon the subject are not prominent, which is typical of the national attitude towards scientific knowledge. Mr. Samuel expressed the opinion that it is impracticable to undertake at the present time legislation on the lines suggested by the memorial.

We regret to record the death of Lady Huggins, at Chelsea, on March 24, after a long illness. From the time of their marriage in 1875, Lady Huggins was the able and unwearying assistant of her distinguished husband, the late Sir William Huggins, and was definitely associated with him as joint author of numerous original papers on astrophysical subjects. Among the investigations in which she took special part were those relating to the spectrum of the great nebula in Orion, the photographic spectra of Uranus and Saturn, absorption bands in the spectrum of Mars, the spectrum of Nova Aurigæ, and the spectra of Wolf-Rayet stars. In laboratory work she collaborated in investigations of the effect of density on the intensities of the H and K lines of calcium, of the modifications of the magnesium line 4481 under different experimental conditions of the spark discharge, and in photographic studies of the spectrum of the spontaneous luminous radiation of radium. Lady Huggins was also joint author of the well-known "Atlas of Representative Stellar Spectra" (1899), which includes the later work of the Tulse Hill Observatory, and a general discussion of the problem of stellar evolution; initial letters and other drawings by Lady Huggins add much to the beauty and interest of this volume. She also acted as joint editor of "The Scientific Papers of Sir William Huggins," published in 1909. In recognition of her valuable services to astrophysics, Lady Huggins was elected an honorary member of the Royal Astronomical Society in 1903.

The death is announced, after a short but painful illness, of Prof. Eberhard Fraas, curator of the geological section of the Royal Natural History Museum, Stuttgart. Prof. Fraas, who was born in 1862, was the son of Prof. Oscar F. von Fraas, whom he succeeded in the curatorship at Stuttgart in 1897. He was a student of Prof. Karl A. von Zittel, of Munich, and devoted his special attention to vertebrate palæontology. His first important work was a memoir on the Labyrinthodonts of the Swabian Trias, published in the *Palaeontographica* in 1889. This was followed in 1891 by a separate volume on the Ichthyosauria from the Jurassic of Würtemberg. In 1894 he first announced Mr. B. Hauff's remarkable discovery of the integument and fins of Ichthyosaurus, and during following years he described several fossil fishes and reptiles obtained by Mr. Hauff from the Upper Lias of Holzmaden. As a curator of the Royal Museum, Prof. Fraas made a special effort to collect systematically the fossil reptiles from the quarries in the Triassic sandstones round Stuttgart, and met with great success. He not only discovered unusually fine examples of Dinosaurians and Crocodilians of known species, but also obtained several new skeletons throwing light on the ancestry of the Chelonians. Most of this collection still awaits detailed description. Prof. Fraas also interested wealthy friends in the Tertiary mammalia of Egypt, and among the specimens obtained was the skull of the most primitive known whale, which he described in 1904 under the name of *Protocetus atavus*. He showed that this skull was intermediate between that of ordinary early toothed whales and that of the early land carnivores (Creodonta). In 1907 ill-health caused him to visit German East Africa, and while there he discovered the first remains of the gigantic Cretaceous dinosaurs, which have subsequently proved to exceed in size even the largest of the dinosaurs known from North America. Prof. Fraas's excellent scientific work will remain as a permanent memorial of his acumen and industry.

The large Australian collections of stone implements are little known to ethnographers. During the recent visit of the British Association, Miss A. C. Breton carefully examined the local museums, and in *Man* for March she gives an account of them. The finest collection, that at Melbourne, has been carefully arranged by Messrs. A. S. Kenyon and D. J. Mahony, who will, it may be hoped, publish an account of it. Their researches tend to show that, as in other countries, the *coup de poign*, once invented, was never forgotten. As other forms became known, all continued in use together until something more serviceable was introduced.

The question has often been asked: Was there an earlier race in occupation of the area in Africa at present held by the Bantus? In *Man* for March Mr. W. H. Beech reports that in the Kikuyu country some ancient pottery has been found, said to be the work of a people called Gumba, who displaced the Maithoachiana, cannibal dwarfs. These Miathoachiana are now believed to be earth-gnomes, skilled in the art of iron-working. Mr. Beech, with some amount of plausibility, suggests that they were possibly Bushmen, Pygmies, or both, and that they were a local indigenous race of the Stone age, who used the flint implements often found in the Kikuyu country. The Gumba are said to have made pottery and to have taught the Kikuyu the art of smelting. They may have been pre-Bantu Hamite invaders; but of this there is no evidence, and the legend may tend to show that the first discovery of iron was made in Africa.

Irish Gardening for March, 1915, contains several useful horticultural papers. One on the different species of Hamamelis, or witch hazel, hardy in the British Isles, is appropriate as these interesting shrubs from China and Virginia are so valuable in the garden in full flower in mid-winter. *Hamamelis mollis*, from China, with its fragrant flowers, is the most beautiful species. *H. virginiana*, from eastern North America, was introduced so long ago as 1736, and is further of interest since witch hazel snow or hazelene snow is prepared from an extract of the bark.

The annual note on the ornamental waterfowl at Kew is always of interest, since so many species breed there in captivity. In 1914 the following birds were reared:—Carolinas; mandarins; common, red-crested, white-eye pochards, and tufted ducks; common sheldrake; Brazilian, common, and Chilian teal; bar-headed, white-fronted, and other geese; and a black-necked swan. Several geese having been destroyed by a badger which took up its abode in the gardens it was decided to dig him out and deport him. When digging him out, his earth was found to be carpeted with bluebell leaves and flowers, and many shovelsful were thrown out.

The *Kew Bulletin* (No. 1., 1915) contains an account of additions to the gardens, museums, library, and herbarium during the past year. Among many interesting presentations to the gardens the most valuable was the fine collection of botanical orchids presented by Lady Lawrence. Collections of filmy ferns in excellent condition have also been received from the Director of Agriculture, Jamaica, Dr. L. Cockayne, New Zealand, and the Assistant-Director of Agriculture, Trinidad. The herbarium has acquired no fewer than 25,500 specimens as donations or exchanges, and 13,500 by purchase. Among the former, Mr. Crossland's collection of British fungi, with drawings, presented by the Bentham Trustees, is one of the most important additions. The Bentham Trustees have also enriched the library with several rare books, and Miss Willmott has presented a copy of her fine work on "The Genus Rosa."

The Canadian Department of Mines has published a Memoir (No. 20-E) upon the goldfields of Nova Scotia by Mr. W. Malcolm. This forms a large volume of some 330 pages, and gives a detailed description of the various gold-producing areas, which together include about one-half of the entire province of Nova Scotia. These descriptions are mainly of local interest, but a good deal will be found of importance to the student of ore deposits, owing to the fact that these particular deposits present a number of specially interesting features. The report shows clearly that the veins belong mainly to the type known as bedded veins—that is to say, mineral veins which are interstratified with, and generally conformable to, the country rocks, though some fissure veins that cross the formations are also met with. To the former class belong the numerous saddle veins, and especially those curious corrugated saddle veins, to which the name of "barrel quartz" is given locally; the peculiar structure of these veins has long attracted the attention of geologists. The memoir has been compiled with great care, the detailed statistics of production being amongst its most welcome features, and it forms a very valuable contribution to our knowledge of these goldfields.

The wet winter of 1914–15 is dealt with in *Symons's Meteorological Magazine* for March in a preliminary way, it being as yet too early to prepare any complete account of the rainfall. Taking the British Isles as a whole, the four months, November and December, 1914, and January and February, 1915, are said to have been all wet, and of these December and February were, relatively to the average, the wettest. November rainfall was below the average in the south of Ireland and in the south-west of Wales, while December was wet everywhere, especially in the south. More than two and a half times the average fell in the south-east of England, and more than three times the average in Sussex. The rainfall of January was double the average at a few stations in England, again chiefly in the south-east. In February more than twice the average rainfall was recorded in the south of England and Wales, in Yorkshire, and in the south and east of Scotland. The rainfall for the four months was 168 per cent. of the average over England and Wales, 139 per cent. over Scotland, 150 per cent. over Ireland, and over the British Isles as a whole it was 155 per cent. of the average. No previous winter seems to have been so wet. In the Thames Valley the general rainfall for the four months was 19·19 in., which is 205 per cent. of the average, and previous records, which exist for thirty-two years, show no aggregate general rainfall for four months over the Thames Valley so much as double the average.

The stability relations of the ternary system $CaO-Al_2O_3-SiO_2$ are studied by Mr. G. A. Rankin in the *American Journal of Science*, vol. xxix (1915), p. 1. Photographs of models, due to the ingenuity of Mr. England, are given; in these, the horizontal positions represent the compositions of the ternary mixtures and the vertical measures give the corresponding melting temperatures. The result has some resemblance to the surface of a mountainous country, the peaks of which represent the melting points of compounds stable at their melting points. The base is an equilateral triangle, the heights above its angles being the respective melting points of the three members of the system, *i.e.* CaO, 2570°; Al_2O_3, 2050°; SiO_2 (cristobalite), 1625° C.

The Washington Bureau of Standards has carried out a useful investigation of the familiar "basic lead acetate solutions." Mr. R. F. Jackson, in Bulletin No. 232, has given a complete equilibrium diagram for the system $H_2O | PbO | PbC_4H_6O_4$. In addition to the free base, $Pb(OH)_2$, and the neutral acetate, $PbC_4H_6O_4$, two double-compounds may exist in equilibrium with the solution. The most important of these has the formula $PbC_4H_6O_4,2PbO,4H_2O$, but there is a narrow range of compositions within which the compound $3PbC_4H_6O_4,PbO,3H_2O$, is the stable phase.

The chemical and mechanical relations of iron, cobalt, and carbon formed the subject of a paper read by Prof. J. O. Arnold at the Institution of Mechanical Engineers on March 19. The paper gives account of research work on the influence of cobalt, from which it appears that the tensile strength increases with the percentage of cobalt present. In annealing tests, with 2·68 per cent. of cobalt present, very little of the combined carbon was precipitated as graphite; two-thirds of the combined carbon passed into the graphitic form in specimens containing 5·5 per cent. cobalt, and in specimens having a higher percentage of cobalt, annealing caused the whole of the combined carbon to pass into the graphitic form. Dr. Arnold, in his remarks, pointed out that there were three true steels: (1) the old iron and carbon steel; (2) the true iron and carbon steel with 5 per cent. of vanadium; in this steel carbide of iron ceased to exist, carbide of vanadium is present; (3) iron and carbon steel having 11·5 per cent. of tungsten; the tungsten expels the carbide of iron, giving the true tungsten steel. Iron and carbon steel hardens at 730° C., vanadium steel at a temperature just before the melting point (1450° C.), and in tungsten steel hardening starts at 850° C., and is not completed until nearly 1200° C.

MESSRS. HENRY SOTHERAN AND CO., of 140 Strand, W.C., and 43 Piccadilly, W., have issued in two parts —Nos. 754 and 755—a catalogue of important works in natural history, including zoology, botany, gardening, farming, microscopy, and geology. The library of the late Prof. Howes is included in the collection. Owing to the war, the volumes are being offered at very low prices.

THE reference in NATURE of March 25 (p. 96) to "three Englishmen, namely Sir A. Geikie, Sir William Ramsay, and Lord Rayleigh," who are members of seven national scientific societies, has brought the inevitable letter from a correspondent suggesting injustice to "Scots." In the case of Prussia we used deliberately the phrase "men of science in Prussia," knowing, of course, that Prof. van't Hoff, though he lives in Berlin, is not a Prussian. It would perhaps have been better to have used the word "Britons" instead of Englishmen in the note, or to have said "men of science in England," as the comparative statement holds good only by taking the place of residence of each person.

OUR ASTRONOMICAL COLUMN.

COMET 1915*a* (MELLISH).—The following is the ephemeris for Mellish's comet for the current week as computed by Messrs. Braae and Fisher-Petersen :—

12h. Berlin Mean Time.

	R.A. (true) h. m. s.	Decl. (true) ° ′	Mag.
March 31	18 2 51	−1 23·1	
April 2	5 9	1 41·2	8·5
,, 4	7 25	2 0·5	
,, 6	9 40	2 21·1	8·3
,, 8	18 11 55	−2 43·2	

The comet is in the constellation of Serpens, and lies a little to the west of the star Eta. It is approaching both the earth and sun, and it will be nearest the earth in about the middle of June. Unfortunately it will be too far south to be seen from these latitudes, but its increasing brightness will make it a conspicuous object for observers in the southern hemisphere. Elements and ephemeris slightly different from the above appear in the Lick Observatory Bulletin No. 268.

THE NINTH SATELLITE OF JUPITER.—An account of the discovery, observations, and orbit of the ninth satellite of Jupiter is given by Seth B. Nicholson in No. 265 of the Lick Observatory Bulletin. The discovery of this faint object (about 19 mag.) was made with the Crossley reflector at the Lick Observatory on plates taken on July 21 and 22 of last year. A series of photographs was being made to secure positions of the faint satellites of Jupiter, and it was on the first plates taken for the eighth satellite that the new member was found. The plate was so exposed that the photographic image of the eighth satellite should not be elongated, and a similar exposure was made on the following night. A comparison of the two plates indicated the image of an almost circular object on both plates near the eighth satellite. Further photographs on July 23 and 24 corroborated the reality of the images in question, and in consequence the discovery was publicly announced. The present bulletin is accompanied by a plate showing reproductions of the photographs taken on July 22, 23, and 24, indicating the eighth and ninth satellites. Mr. Nicholson next describes the computation of the orbit of the new body by Leuschner's method, and gives the approximate elements calculated by him, together with those of the eighth satellite derived by Crawford and Meyer for comparison. These serve to establish the identity of the object and to describe the nature of its orbit. The motion, like that of the eighth satellite, is retrograde.

	IX. Epoch and Osculation 1914 July 27·8817 G.M.T.		VIII. 1908 March 8·8233 G.M.T.	
M_0	49° 28′		266° 4′	
ω	71 10	1914·0	67 46	1908·0
☊	309 23	1914·0	240 2	1908·0
i	157 51	1914·0	144 51	1908·0
e	0·1630		0·3520	
μ	0°·3154		0°·4573	
P	3·125 years		2·155 years	
log *a*	9·3232		9·2156	

RELATIVE PROPER MOTIONS OF THE PLEIADES.—In the *Astronomische Nachrichten* No. 4790 Dr. R. Trümpler gives details of an interesting investigation on the relative proper motions of the Pleiades group. The work is based chiefly on a previous research (1901) by J. Lagrula entitled "Etude sur les occultations d'amas d'etoiles par la lune avec un catalogue normal des Pléiades," in which the differential positions of 102 stars in the Pleiades group in relation to the central star of η Tauri were determined. Dr. Trümpler derives the following conclusions from Lagrula's proper motions of forty-three stars. The relative proper motions of the eleven brightest stars are very small. The relative motions of the fainter stars have larger velocities than the bright stars, and exceed the limit of errors of the determinations. The proper motions of the fainter stars indicate a systematic variation from those of the brighter stars, or, in other words, the system of the fainter stars appears to displace itself with regard to the system of the brightest stars. In the case of the fainter stars there is indicated a movement of rotation in the direction of decreasing position angle, one rotation being of the order of two million years; the brightest stars appear to take either no part or only a very small part in this movement. The point of radiation for the proper motions of the Pleiades cannot be deduced with certainty. It can only be said that from the observed radial velocities of the brightest stars the parallaxes of the Pleiades must be smaller than 0·1″.

REPORT OF THE STONYHURST COLLEGE OBSERVATORY.—The report of the director of the Stonyhurst College Observatory for the year 1914 consists for the main part of the results of the meteorological, magnetical, and seismological observations. Reference to the astronomical work accomplished during the past year is incorporated under the heading, "Report and Notes by the Director." These include, first, the results of the measures of the disc areas of sun-spots as measured from drawings. It is shown that the year 1913 was the minimum year of sun-spot activity, while the year 1912 was the minimum year for the mean range of magnetic declination. These results are in accordance with those published in this column for March 18 (p. 75). An account is also given of the expedition to Hernösand, Sweden, to observe the total solar eclipse of August 21, 1914. Reference is made to the record of the strong red radiation coronal line 6374·3, which is described here as "a strong member of a band or fluting. . . ." The presence of this coronal radiation was first announced by M. Deslandres (*Comptes rendus*, November 16), and was soon corroborated by M. Carrasco by the examination of his own eclipse spectrograms.

RECENT WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

IN No. 82 of the handsome series of Professional Papers published by the United States Geological Survey, Myron L. Fuller describes "The Geology of Long Island, New York." This suburban island, from the lively beach of Coney Island on the west to the old-time refinements of Easthampton, protects the Connecticut coast for more than a hundred miles. Its core consists of sandy strata, which are now recognised as Cretaceous; these appear at the base of the bluffs of the north coast and in wells in the interior. The early events of the Ice age piled the Manhasset Formation across them, and on the somewhat irregular plateau thus built up two great moraines were deposited as records of the Wisconsin epoch of ice-advance. One of these appears conspicuously along the axis of the island, while the younger moraine lies near to the north coast. The sandy plains formed by the outwashed material from these ridges cover a large part of the country. The present memoir, with its two large folding maps, may not appeal to the motorists who denude the roads on Sundays; but it will be prized on the shelves of those cultured citizens who have built their summer homes among the gracious woods and inlets of the sound.

It is a long stretch from the New York shores to the shifting mouths of the Mississippi. E. W. Shaw, in No. 85-B, deals with the mud lumps that attracted Lyell as examples of the seaward growth of land, and concludes that they arise from the creep of semi-fluid clay from beneath the land and the shallows, under the pressure of new alluvium deposited by flooding. Where currents sift the delta-material, leaving sandy banks behind, the resistance to outward flow is sufficient to cause the moving clay to rise up to the surface. Some of the lumps stand 8 ft. above the water. Unless they subside, they are worn away by the sea in a few years. The reader of this paper must remember that a "pass" in the delta is not a passageway, but a delta-finger dividing one bay from another.

Oklahoma, the paradise of protected Indians, is being explored for oil-pools, and the illustrations in Bulletin 547 introduce us to the broad alluvium-filled valleys of the country, in which the rivers may run almost dry, while sand-dunes (p. 31) may gather near their banks. The conditions remind us of those of Permian times in England. Another interesting view of river-action in easily denuded strata is given in Bulletin 575, where the Grand River, a tributary of the Missouri in South Dakota, is seen meandering on a great plain of level Pierre Shale, leaving outliers of the more resisting Foxford Sandstone, the highest marine Cretaceous deposit, standing out above it. To the west, in Wyoming, the Cretaceous beds, though still frequently horizontal, are associated with mountainous outcrops of contorted Carboniferous rocks, and the rainfall allows of a thick growth of trees across them (Bull. 543, "Lincoln County, Wyoming," by A. R. Schultz). In Professional Paper 78, W. H. Emmons and F. C. Calkins guide us through a high and ice-carved region around Philipsburg in western Montana, which was lifted from the sea with the central Rocky Mountains in earliest Eocene times. Pre-Cambrian rocks here come to light, and it is interesting to note that features of stoping and intimate penetration, resembling those so well seen in Finland, have arisen in them by the intrusion of Cainozoic granodiorite during the general uplift (Fig. 1). A careful description is given of the products of contact-metamorphism and of exhalation from the igneous invaders. The district includes ores of gold and silver, imported by these early Cainozoic intrusive bodies (p. 186). The first mining operations were undertaken twenty-five years before the arrival of the railway, and exploitation has now so far worked away the ores that the small town of Philipsburg may look forward to relying on its agricultural industries. The usual beautifully printed maps accompany this memoir.

Early Eocene granite appears on the west flank of the mountains in Idaho (Bulletin 528, "Geology and Ore Deposits of Lemhi County," by J. B. Umpleby), and it suffered from erosion in Middle Eocene times

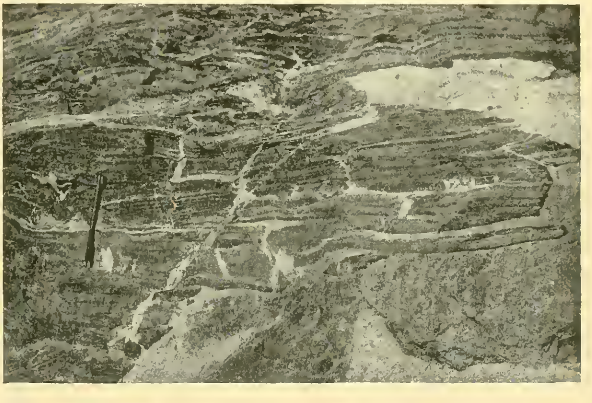

FIG. 1.—Stoping and absorption-features at contact of Cainozoic granodiorite and Algonkian sediments, Storm Lake, Montana.

(p. 43). Gold-bearing veins are associated with the rhyolitic lavas that broke out in the area in the Miocene, and possibly the Pliocene period, and this bulletin is largely concerned with mining. The main routes for traffic are eastward; the differences of elevation cause a great variety of climatic conditions in Lemhi County, but the photographs around Salmon City have a distinctly pleasing air. The same author describes a somewhat similar region in Bulletin 539 ("Some Ore Deposits in North-Western Custer County, Idaho"), where the open season lasts from the beginning of May to the end of October, and where tetrahedrite and galena are mined at 8000 ft. and upwards above the sea. A remarkable erosion-surface, developed near base-level in Eocene times, has left traces that are now elevated to 9600 ft., with valley-floors 5000 ft. below them. The mines on Poverty Flat thus stand at 9500 ft., on the margin of a partly wooded plateau covering twenty-five square miles, which has been worn as a peneplane across steeply tilted Palæozoic rocks. As a result of elevation, valleys were developed in the Miocene lacustrine strata to a depth of more than 4000 ft., prior to their occupation by the post-Pliocene glaciers (p. 17). These figures serve to illustrate the removal of Flysch beds and other Cainozoic strata during Pliocene times from the surface of our European Alps.

B. S. Butler, in Professional Paper 80, reports on the copper and other ores of the San Francisco district in Utah. The mines lie in the arid Great Basin, near the south end of the lost Lake Bonneville. The block-structure of the country is rendered all the more interesting by the continuation of the faulting into recent times. The intrusion of quartz-monzonite in a Cainozoic epoch (p. 70) has produced diopside as a common contact-product in the early Palæozoic limestones, and an example (pl. xii., Fig. A), where this has become altered into serpentine is of interest for comparison with various "eozoonal" rocks.

"The San Franciscan Volcanic Field, Arizona," described by H. H. Robinson (Professional Paper 76), lies three hundred miles farther to the south, beyond the Grand Canyon country, but sufficiently near to allow of a confusion of the mountain names. San Francisco Peak, rising 12,611 ft. above the sea, retains its general form as a great volcano with secondary cones, and fine igneous studies can be made in the ravines upon its flanks. It is believed (p. 52) to have originally risen 8800 ft. above the plateau of horizontal Carboniferous rocks, and to have lost 3000 ft. by denudation. This region stood close to sea-level in late Pliocene times, and then became deluged by flows of basalt; elevation by faulting followed, and rhyolites and andesites appeared on the surface as it underwent dissection. The great volcanoes belong to this epoch, at the opening of the Quaternary era. A far greater elevation, amounting to thousands of feet, then took place, introducing "the present or canyon cycle of erosion" (p. 93), and scattered vents emitted basalt and built up lava and scoria cones (see Fig. 2). The railway across the Colorado Plateau, from which a branch runs north to the Grand Canyon, gives access to this volcanic field. The great cone of Bill Williams Mountain, named after a scout killed in Indian warfare, is already ascended by a tourist-track, and in time we may hope that Flagstaff Station will be as famous among geologists as Mont Dore. Visitors will pass on, however, to the canyon country, and L. F. Noble (Bulletin 549) revives our memories of Dutton's survey in the fine illustrations to his work on "The Shinumo Quadrangle." In the region treated there is only one permanent habitation. Plate xviii. shows the geological history of the country, concerning which much has been learnt since Dutton's work, as recorded in a natural section rising a mile above the river. A hill of inclined Algonkian quartzite is seen half-way up, buried by horizontal strata from Cambrian to Upper Carboniferous. H. H. Robinson, the author of the paper on the San Franciscan volcanic field, is cited (p. 91) as providing the most recent summary of the physical history of the canyon country.

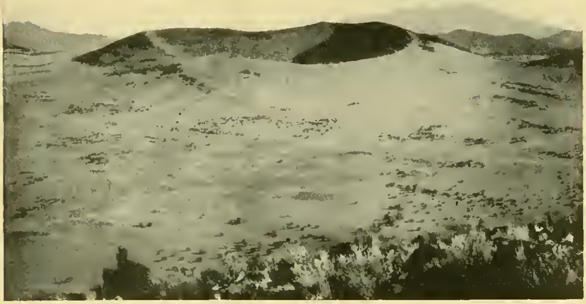

FIG. 2.—Recent cone formed of ash with lava above, north-east edge of the San Francisco volcanic field.

Alaska, which is being explored so conscientiously, is represented by nine bulletins published in 1913 and 1914. While these are mostly concerned with mining prospects, glacialists will appreciate the evidence of the forward movement of ice across forests in Bulletin 526, and of the formation of "push moraines" 25 ft. high, where a glacier-nose impinges upon beach-deposits. Though boulder-clays are rarely specifically mentioned, it is clear that a large part of the Alaskan "moraine" material is of this character. In Bulletin 534, for instance (p. 43), on the Yentna district, we read that "deposits of glacial till of the ground moraine type are widespread," up to 75 ft. in thickness, with particularly abundant striated pebbles and boulders.

Among publications dealing with minerals, we may note the illustrated descriptions of Ferberite, or wolfram free from manganese, by F. L. Hess and W. T. Schaller, in Bulletin 583. The latter author investigates the crystallography of the species. Alunite attracts attention in Bulletin 540 ("Contributions to Economic Geology, 1912," published in 1914, p. 347). Numerous saline deposits have been prospected without results for potash salts on a commercial scale (p. 406). The phosphatic shales at the top of the Carboniferous beds in Idaho, and probably of Permian age, are described in Bulletin 577. No. 585 consists of a list, with localities, of all the useful minerals and rocks of the United States, arranged under the States in which they occur. H. S. Gale refers the calcium borate, Colemanite, of southern California to the emission of boric acid from basaltic lavas into travertine deposits of Miocene age (Professional Paper 85-A, p. 8).

G. A. J. C.

THE POSITION OF THE ORGANIC CHEMICAL INDUSTRY.[1]

THE value of the colouring matters consumed in the United Kingdom is 2,000,000*l.* per annum, and these dyes are essential to textile industries, representing at least 200,000,000*l.* a year, and employing 1,500,000 workers, and to many other industries, such as the wall-paper, printing, and paint industries, requiring lakes and pigments. In recent years Germany has supplied this country with nearly all these dyes, with organic chemicals required for photographic purposes, with the natural and artificial products used in the manufacture of scents and perfumes, with synthetic and other drugs and disinfectants, and

[1] Abstract of the presidential address delivered before the Chemical Society on March 25 by Prof. W. H. Perkin, F.R.S.

with nearly all the fine chemicals. As a result of allowing these trades to pass so much out of our hands, we are faced with the position that stocks are rapidly diminishing and prices are rising to such an extent as seriously to hamper many of our industries.

The great dyeing industry has been lost to this country because we, as a nation, and our manufacturers in particular have failed to understand the extreme complexity of the scientific basis of organic chemical industry. Science has been neglected in the works, and the chemists trained in organic chemistry necessary to carry on the industry in successful competition with Germany were not to be found in our universities. In 1870, the time when this industry commenced to be transferred to Germany, organic chemistry was not recognised by our older universities, and the newer universities, which since then have done so much for the progress of science, did not exist.

Many of our universities, and particularly those of Oxford and Cambridge and those in Scotland, contributed practically nothing to the advancement of organic chemistry in the latter part of last century, and even now their output of research is far less than it should be; while in Germany, as soon as the importance of the subject became apparent, schools especially devoted to the subject were founded by such great teachers as Liebig, Wöhler, Kekulé, and Baeyer. Every effort was made by the establishment of laboratories, aided by the State, to help forward the new movement, and the step which assisted more than anything else was the provision that in every German university, research must be an essential part in the training of every student of chemistry, who, in order to obtain his degree of Ph.D., spends at least one and generally two years in research; whilst in this country, students obtain their B.Sc. honours degree after a course of three years' study, and the majority are under no obligation to do any original research during their university career.

The recognition of the necessity for research forming an essential part of the training of the student in science has been responsible for the large output of original work in Germany as compared with this country. The B.Sc. degree, and certainly the B.Sc. honours, should not be conferred except on those who have undergone a course of research work, and the necessity for a change in this direction is now being recognised, though the proportion of graduates who engage in research in these circumstances is small compared with the number of Germans who qualify for the Ph.D. degree. Had there been a supply of first-rate chemists at the disposal of the manufacturers of this country there can be no doubt that such industries as the aniline dye industry and the coal tar industry would still be in existence and flourishing here.

Germany has recognised the value of the closest possible contact between the industries and universities, and the majority of the professors and privatdocenten keep in touch with the large factories. Appreciation by the manufacturers of the value of science in connection with industry is one of the reasons for the development of the German chemical works. To obtain a share of the wealth and prosperity opened by this vast industry, our manufacturer must so conduct his works that research is going on unceasingly; his laboratories must be properly equipped and staffed by research chemists of ability, with a scientific leader to direct the work; for the first essential for the success of a chemical works is for it to be under chemical control, and every department must be in the hands of an expert. Recognition of the soundness of this principle is one of the main reasons for the success of the works in Germany, where all the principal dye works are under chemical control; chemists are the heads of departments, and are included in a large proportion on the board of management.

In order to deal with the problem of the shortage of dyes in this country, schemes have been proposed by the Government to ascertain the best means of obtaining sufficient supplies of chemical products. The first scheme recommended by the special committee appointed by the Government was not cordially received, and in explanation of this it should be pointed out that the committee consisted entirely of business men. Had a chemical expert been present, such a scheme would not have been placed before the public. In the memorandum of agreement it is stated that the company has been incorporated for the purpose, amongst other things, of manufacturing and selling dyes, colours, and other chemical substances which, previous to the war, were exclusively or principally manufactured in Germany, and no mention is made of the main object of such a company—namely, the employment of a large staff of research chemists under leaders of ability for the purpose of making discoveries in every possible direction.

It is not merely a question of producing the dyes that are required during the war; the company must be able to compete successfully with the German industries after the war. No greater mistake could be made than to think that in order to manufacture a dye it is only necessary to follow the directions given in the patent, for the patent is so worded that while it satisfies the requirements of the patent laws of the countries in which it is taken out, it gives as little information as possible, and contains no indication of the process used in the actual manufacture. In the first place the methods of manufacture and the utilisation of by-products must be worked out until they have arrived at the same state of efficiency as in Germany. Another point to be borne in mind is that the Germans supply dyes to practically all the other nations, and could well afford to sell dyes at a loss to themselves in this country until the English company had been ruined. And what will happen after the war with regard to using German patents? Will these patents again become the sole property of the Germans and be workable in this country only on the payment of royalties or licenses?

The application for shares in the proposed company was unsatisfactory. The Government withdrew the first scheme and substituted an amended proposal which is a proof of a desire to meet in a generous spirit the criticisms raised against the first scheme. The grant of 100,000*l.* which the Government proposed to make to the company for research purposes would be better employed in subsidising the research laboratories of those universities and colleges willing to specialise in organic chemistry and to train a certain number of students with a view of their entering the service of the company.

The existing dye works in this country compare very unfavourably with those in Germany, where experience has been in favour of building large works and against spreading manufacturing operations over small works situated in different parts of the country. Moreover, in the manufacture of any substance by-products result, which must either be recovered or used in the manufacture of other saleable products, and in order that these by-products may be used to the best advantage, the dove-tailing operations should be carried out on the same site, and thus save transporting the by-products from one works to another, an operation that must entail loss. The proposal of the Government, therefore, to take over the existing works in this country appears a doubtful policy.

The German works with which the new British company must compete are enormous organisations controlling almost unlimited resources, and if after the war these organisations continue to work with the same efficiency as before, some years must elapse before we could compete successfully with them. Failure to develop on research lines is scarcely conceivable if the works are in the hands of a highly trained chemical staff; but if the new industries get into the power of the business man who wants an immediate return for his outlay and fails to appreciate the vital importance of scientific control, then no protection by a tariff on the import of German dyes and other organic products can avert disaster.

THE CO-OPERATION OF SCIENCE AND INDUSTRY.

A DISCUSSION upon the above subject took place at a conference held under the auspices of the Institute of Industry and Science at the Mansion House on March 25. The chairman, Mr. Frank Warner (president of the Silk Association), in opening the proceedings, dealt with the crying need for a greater application of science to industrial problems and for the need of the organisation of industry. The two main objects of the Institute of Industry and Science he defined as the organisation of capital for industrial purposes, and the bringing about of those working conditions in which science and industry are in closer contact.

Mr. Taylor Peddie, chairman of the Institute, stated that the Institute aimed at embracing within its membership the trade organisations of the country, and that already much progress had been made in this direction and with the formation of a trade bank. Prominent men of science had joined the court of directors of the Institute, and by development of this scheme it was hoped to bring science into intimate contact with industry. Mr. Peddie then opened the discussion by reading a paper upon "The Influence of Science upon Political Economy," in the course of which he demonstrated from comparative statistics the large reductions in the cost of production that had been brought about by the application of science to processes of manufacture.

Sir Philip Magnus stated that the output of research work from the English universities was equal to that of Germany, and that their graduates were as capable and as well trained as those from the German universities; but that, owing to our lack of appreciation of science, we made practically no use of our research work, nor of our trained men. He felt that any movement trying to bring about a more marked sympathy between science and industry was worthy of the greatest support.

The Earl of Portsmouth, in moving a resolution to the effect that the meeting supported the organisation of capital for industrial purposes, and that it agreed that a closer co-operation of science and industry was essential, stated that he was of opinion that in the near future the people now drawing their income from land and property would by force of circumstances be compelled to turn their attention to industrial affairs.

The Hon. F. Mackenzie (Agent-General for New Zealand), in seconding the resolution, expressed the opinion that we were too prosperous in this country to appreciate the need for organisation. He stated that twenty-five years ago agriculture in New Zealand was at a very low ebb, farmers were selling sheep at the rate of 18*s*. 9*d*. a gross, butter was 4*d*. a lb., but now, through careful organisation and the application of science to agriculture, New Zealand was a prosperous country, exporting a considerable amount of produce to England.

S. R. I.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE spring meetings of the Institution of Naval Architects opened on Wednesday, March 24. Owing to the war, the meetings were curtailed somewhat; eleven papers were read and discussed at morning and afternoon meetings on Wednesday and Thursday. The Marquis of Bristol was re-elected president for the ensuing year, and in his opening address made reference to Germany's methods of submarine war. He suggested that, in order to obtain reasonable protection from submarine attack, it might be advisable to arm all merchant vessels to an extent which would render them dangerous to submarines.

Prof. J. J. Welch's paper on the watertight subdivision of ships was limited to a discussion of the orderly subdivision of ships, particularly as effected by transverse watertight bulkheads. The paper included a historical sketch leading up to the work of the bulkhead committee of 1912. One of the difficulties which had to be faced by this committee was the question of permeability. The same ship, whilst loaded to the same water-line, might carry cargo of very different density, so that with the same arrangement of bulkheads different standards of safety would obtain on the two voyages. Ultimately the conclusion was reached that a fair average permeability for cargo spaces was 60 per cent. Spaces devoted to passengers are taken at 95 per cent. permeability, and machinery spaces at 80 per cent. The paper goes on to discuss the recommendations of the bulkhead committee's report on oversea passenger vessels, and the author considers that the proposals in the report represent a very decided step forward.

An interesting paper on the influence of discharging appliances on the design of large ore carriers was read by Mr. John Reid. The shipment of ore on the Lakes Superior and Erie route has reached in one year the enormous total of nearly 50,000,000 tons. The author gives a description of the Hulett unloading machine, an appliance which has enabled a cargo of 10,000 tons of ore to be unloaded on the Great Lakes in less than three hours. Unloading and loading machinery of this description has led to the design of ore-carrying steamers in which the greater part of the length of the vessel is taken up with cargo holds, and practically the whole deck is covered with hatches. The rapid loading of such vessels is apt to produce great strains; a speaker in the discussion instanced a case of one of these vessels acquiring a deflection of 11½ in. during loading. The author of the paper directed attention to the backward state of the facilities in Great Britain for handling and transporting ore, and showed how some of the leading features of the Great Lake ore-carriers may be adapted with advantage for ocean-going ore-carriers.

Mr. J. Montgomerie read a paper on the scantlings of light superstructures, by which is meant the light steel deckhouse erections now commonly fitted above the strength deck in passenger steamers. Two alternatives present themselves to the designer:—(1) The structure may be made so flexible that it cannot take any share in the straining action to which the vessel is exposed as a whole; (2) it may be made strong and rigid enough to share that general straining action without damage. The first method of design is impracticable, since the superstructures have to carry heavy weights such as boats, casings, and funnels, and the structure has to be substantial enough to support these when the ship is moving in a seaway. Partial flexibility may be obtained by cutting the superstructure at several places and fitting expansion joints. The whole efficiency of such joints, in respect of the relief from stress which they afford to a long house, depends on the distance between them, and that in turn states a problem in shipbuilding which has never been solved satisfactorily, viz., the determination of the distribution of stress in way of an abrupt discontinuity, such as a bridge, or other erection. In the absence of any theory to which complete assent can be given, we must turn to the record of experience. The author then proceeds to give descriptions and illustrative sketches showing typical cases of damage to existing ships at places of discontinuity. These examples are of particular value to engineers and others interested in the strength of materials, and will well repay careful study.

An analysis of the damage observed supports certain conclusions which can be drawn from a consideration of the whole question of superstructures:—(1) That in way of a discontinuity in the structure of a ship, stresses outside the erection will be transmitted to the material of the deeper girder much more rapidly than has been thought to be the case; (2) that the fitting of expansion joints, spaced as in the present practice, does not appreciably relieve the superstructures of stress, or obviate damage; (3) the best method of providing against damage in deckhouse superstructures is to dispose the material so as to make these capable of taking part in the straining action of the hull, following as far as possible the general law that all discontinuity of longitudinal material should be minimised. The author then proceeds to take certain typical cases, and gives methods of working out the scantlings required to comply with (3), above noted.

Mr. F. W. Lanchester gave a contribution to the theory of propulsion and the screw propeller. The author made reference to the controversy in which Dr. Froude's work was attacked violently by Prof. Henderson. Without entering, or taking part, in the dispute, Mr. Lanchester reviews the theory from its foundation, in order to make sure of his own ground. In the past there appears to have been insufficient attention to the initial definition of the problem, with corresponding uncertainty as to the ultimate interpretation of results. In discussing Dr. Froude's theory, and speaking academically, Mr. Lanchester says that the weak point of the whole conception is that there is no proof offered that either the work done (*i.e.* the energy expended), or the momentum communicated, is confined strictly to the column of fluid passing through the actuator, and there is, in fact, nothing to restrict, or confine, the fluid as in the case of the efflux theory, by which the problem is rendered really definite. It is understood that the *régime* contemplated by Dr. Froude is not capable of exact expression. This, however, is no obstacle to the application of any theory in real hydrodynamics; if it were necessary for the engineer to await the work of the pure mathematician in these matters, the subject would have made scarcely perceptible progress since the time of Noah. In such a case as the present, if the method of treatment contains 80 or 90 per cent. of truth, it may demand acceptance.

Further work at the William Froude National Tank on the resistance of mercantile ship forms was presented by Mr. J. L. Kent, and Mr. Stromeyer contributed an interesting paper on the law of fatigue applied to crankshaft failures.

EAR PROTECTION AGAINST ARTILLERY SOUNDS.

THOSE who have associated with our gunners must have noticed how often they suffer from deafness. The sudden access of pressure in the neighbourhood of a gun at the moment of firing imposes so great a strain on the drum of the ear that deafness is a usual result. The increase in pressure in the modern gun, and the high pressure still remaining when the shot reaches the muzzle, make the conditions more serious than they used to be comparatively recently. Not only those who are near the gun when fired, but those also in the neighbourhood of bursting shells, bombs, or explosives, are liable to suffer in a similar way even if they are not otherwise damaged.

Mr. A. Mallock, F.R.S., who has for many years conducted investigations in connection with artillery, has invented an "ear defender," the object of which is to protect the drum of the ear from very sudden and violent access of pressure, while still allowing the minute variations produced by ordinary sounds to be received with but little loss. The defender consists of a containing piece made of ebonite and shaped like the pieces used in the game of Halma, and of about the same size. The ball end is very finely milled, and it is made to fit the passage of the ear, there being five sizes, differing very slightly in size in this part, to suit different people. The piece is pierced centrally by a hole 5 mm. in diameter at the small end, and gradually enlarging towards the other end, where it opens into a recess 1 cm. in diameter. Into this are fitted in order a flat ring washer, a disc of fine wire gauze, a very thin, flat ring washer, a delicate diaphragm, a very thin, flat ring washer, a disc of fine wire gauze, and a flat ring washer. When a pair of defenders are placed in the ears, the thin diaphragms, untouched except near their edges, where they are held, are free to take up aerial vibration and to transmit it to the ear passage, and so the wearer hears ordinary sounds with but little loss; when, however, the violent impact due to gun fire or explosion in the neighbourhood occurs, the diaphragm is brought up against the wire gauze, by which it is prevented from further movement, thus limiting the increase of pressure in the air passage and defending the ear.

The defenders are neatly packed in a small tin matchbox with a rubber fitting, which prevents them from falling out, but which allows them to be removed at once. A small cleaning tool is similarly held elastically so that it cannot fall out by accident. The price of the set is three shillings, and at the present time there is great scope for its use. The instrument is called the Mallock-Armstrong ear defender, and the address of the proprietors is 86 York Street, Westminster.

C. V. B.

SOME SCIENTIFIC ASPECTS OF PIANO-PLAYERS.[1]

THERE are few modern inventions which have not been employed in the present war for the destruction of property and of human life. The pneumatic piano-player is an exception. It is also exceptional in that it possesses but a scanty literature outside the catalogues of the manufacturers. It has never been associated with any inventor of distinction, and the general public knows nothing about its history. The aeroplane, on the other hand, is closely linked in popular thought, not only with such modern names as Wright, Langley, and Blériot, but also with the names of early designers and projectors of flying machines, such as Dante of Perugia and Leonardo da Vinci. Yet, considered merely from an engineering point of view, the modern piano-player is a marvel of human ingenuity.

The feature which distinguishes it from its early predecessors is the element of controllability, which leaves the interpretation of the music largely to the

[1] Abridged from a discourse delivered at the Royal Institution on Friday, March 19, by Prof. G. H. Bryan, F.R.S.

choice of the performer. Of recent years, however, personal control has been supplemented by accent devices, automatically operated, the construction of which is essentially an engineering problem. The separation of the scale into two independently controlled halves was certainly to be found in the old mechanical pianotist in 1902, and it may date from still earlier. I consider this last feature unnecessary, and its use open to serious objections.

The object of my experiments has been to apply dynamical and physical principles to the control of what I will call the striking action in piano-players, as it very soon appeared to me probable that by so doing it would be possible to obtain differences of effect that could not be produced by purely mechanical methods.

The ordinary practical man asserts that in striking a note or chord on the piano you can increase or decrease the force of the blow, but that the only effect will be to play the whole chord louder or softer, so that you cannot bring the bass or treble parts into prominence unless you connect the pneumatics with different degrees of vacuum. I have been told that it is mathematically impossible to produce effects without which I now regard no piano-player as worth playing.

But any mathematical physicist will understand that what engineers call the "force of the blow" is in reality a very complex phenomenon. In my piano I find that a fairly soft note is produced *in the middle of the scale* when the hammer strikes the strings with a velocity of 30 cm. per second, and that the hammers themselves rise through a height of about 5 cm. This means that *if the acceleration were uniform* the operation of depressing the key and releasing the hammer would occupy one-third of a second. But during the operation the pressure applied to the key may be increased or decreased in an infinite number of ways. It may be made very large at the commencement of the blow, sinking to zero at the end, as when a finger-pianist strikes the note from a height; or it may be very small at first and gradually increased, an action which some describe as a "caressing" touch. These differences would be represented by differences in the shape of the graph connecting the pressure on the key with the time measured from the instant it is first touched to the instant that the note is sounded. We might call them differences in the "shape of the blow." But the check action greatly influences the character of the accelerating force impressed on the hammer when regarded as a function of the time. The operation of playing a note is usually divided into two periods. At the end of the first period a support is withdrawn from the palet which raises the hammer, and the latter becomes disconnected. In the second period either the hammer may fly up freely and strike the note, or the palet may again overtake it and drive it forwards. To produce these different actions the variable forces applied to the key of a piano must evidently be similar in character to the "screw-back" and "following" strokes in billiards. It is, of course, theoretically possible that the hammer may rebound and strike the string a second time. But it is very difficult to test this point.

Another important point is that, as the driving force is applied close to the base of the hammer, considerable flexural vibrations are liable to be set up in the shaft. These may probably differ in amplitude and phase, according to how the note is struck. A difference in this respect may affect the tone-quality.

Now the bass and treble hammers differ considerably in weight, and therefore also in inertia, and the intermediate hammers vary continuously from one end of the scale to the other. It follows that a short sharp blow will produce its greatest effect in the higher parts of the scale, while a longer sustained blow, or an increasing blow, will drive the bass notes forward with increased velocity even after the treble notes have been released.

In the case of a repeated treble note with bass accompaniment the second time it is struck, accentuation is more difficult, and there is considerable danger of the note failing to sound owing to the bridge between the two notes buckling, thus continuously admitting air to the primary valves. The best plan is to keep the tension low until the chord containing the repeated note has passed the tracker board, and then force the notes down hard. On account of the additional difficulty thus incurred in reading the music, I believe that it would be justifiable to cut the troublesome note a little after the accompanying chord.

The apparatus originally used in these experiments was figured and described in NATURE of May 8, 1913 (vol. xci., p. 246), but the principle has now been embodied in a patented device which the Moto Music Company, of 42 Eyre Place, Edinburgh, have undertaken to fit to any make of internal or detachable player, and which in the case of a player-piano does not interfere with the appearance of the instrument or its use when required for hand playing. In addition to the suction bellows which generates the vacuum, all pneumatic players have a large reservoir bellows, which acts as an accumulator or condenser of considerable capacity, but between this and the playing pneumatics two channels of communication usually exist. One is through an accent valve controlled by a lever, the other connection is through a smallish regulating bellows, controlled usually by a spring, and through an air valve which opens or closes with it according to the degree of vacuum. This arrangement is sometimes called a "choker," and its statical action tends to equalise the pressure of the air from the playing pneumatics.

Now it will be found that in playing the regulating bellows is in a continual state of vibration, and that this vibration has a very marked effect upon the tone quality and expression. The character of the variable force applied in projecting the pianoforte hammer is determined very largely by the elasticity of the controlling spring, and the fact that this remains constant is found to account for the dulness and want of variety which is noticed even in the best players when they have been in use for a certain time. In my device the spring is replaced by a weight the leverage of which can be varied, thus enabling the tension on the bellows to be varied from time to time in playing different passages, and introducing, further, a variable element of inertia. It is convenient to describe such changes as "sub-permanent." Further, the bellows can be controlled by a hand lever for the purpose of accentuating individual notes, such changes being describable as "temporary." The usual expression marks, F F, F, M F, P, and P P, are indicated.

The experiments lead to the following conclusions:—

(1) A light sub-permanent tension with fairly strong pedalling will give bright treble effects with light bass. A heavy sub-permanent tension with light pedalling produces a strong bass and a soft treble.

(2) Corresponding to every note of the scale, there is an action which produces the maximum effect, this action varying continuously from one end of the scale to the other.

(3) The brightest effects are obtained by keeping the accent valve open, or partly so, as in this case the closing of the regulating bellows is affected by the pedalling. The effect of closing the accent valve is very similar to the use of the soft pedal.

(4) In playing solo passages, light and heavy sub-

permanent tensions produce different effects even when it is sought to maintain the corresponding degree of loudness by suitable variations in the strength and method of pedalling. This observation leads us to believe in the existence of a relation between tone-quality and touch. While it is easy for an inexperienced person to produce the necessary differences of touch with a pneumatic player fitted with this controlling device, I find it very difficult to obtain the same effects by striking the keys of an ordinary piano with my fingers.

(5) There appear to be two different ways of accenting particular parts of chords by hand pressure applied to the control lever. With a slight sub-permanent tension, treble notes are usually best accented by depressing the lever before the note has reached the tracker board, and subsequently allowing it to fly up smartly. With a heavy sub-permanent tension, it is necessary to jerk the lever upwards from below just after the note has reached the tracker board. For a bass note with light tension, the lever is firmly pressed down after the note has reached the tracker. With heavy tension the lever is previously raised, and then allowed to drop down with the note. In either case the action is supplemented by a corresponding action in pedalling.

(6) With a heavy sub-permanent tension and the lever supported from below, it is possible to obtain very soft effects in which the treble parts ring out clearly and are not drowned by the bass. With a light sub-permanent tension and the lever pressed down the results are more brilliant. I attribute these differences to the inertia of the controlling weight.

(7) There is a great satisfaction in being able to slam down a vigorous chord, hand and foot working in unison.

(8) In the earlier experiments the connection between the lever and the bellows was made first with strings and tapes, and afterwards with wires passing over pulleys. It was found, however, that the stretching of these connections greatly interfered with the effects and led to the production of harsh results, and the connections frequently broke.

(9) The best accentuation of particular notes in chords is obtainable when the notes reach the openings in the tracker board at exactly the same instant. When they are cut unevenly it is often very difficult to accentuate at will either the upper or lower notes of a chord.

(10) With experience it is possible to learn the exact kind of effort required to accentuate a note in any part of the scale, and thus to obtain marked differences between the treble and bass parts of a comparatively short chord.

(11) Where a note or chord is repeated a number of times in rapid succession it is advantageous to hold the controlling lever firmly. This obviates all the strain on the ankles in pedalling, which under ordinary conditions is considerable.

(12) In every case the exertion of pedalling is greatly reduced, not improbably by about 50 per cent.

(13) Some players have separate regulating bellows for the bass and treble parts, but this does not interfere with the working of the device.

(14) A very small effort often produces a considerable difference in the effect. It is possible to emphasise a particular note or chord by a suitable stroke of the pedals alone, but the lightest possible touch of a finger applied to the lever will often produce a conspicuous improvement in the effect.

(15) Experiments with pianos of different makes, both upright and horizontal, operated by either detachable or interior players, lead to practically identical results.

Although I have been trying for a long time past to account theoretically for the observed effects, the results are still far short of finality. It is clear that neither Helmholtz's nor Kaufmann's mathematical investigations fully suffice for the purpose. There are, however, other difficulties. One is that, although it is easy to observe differences of effect which are, as a rule, quite conspicuous, it is not as easy to define exactly in what these differences consist. Again, the success of a piano-player as a musical instrument largely arises from the fact that the manipulation of the various controls, both for tempo and expression, soon becomes intuitive. A great deal evidently depends on the elasticity of the muscles of the hands and feet. It would be very difficult to ascertain precisely the effect of differences in this elasticity on the tension in the playing pneumatics while a note is being sounded. In short, it appears probable that a complete dynamical theory of the observed effects will involve investigations of no small degree of difficulty. The mere engineering of this control device into a form in which it can easily be adapted to any internally fitted player without interfering with its use for hand playing, has given Mr. Ireland a great deal of trouble. It is now important that the experiments should be repeated by a number of different independent observers, and their experiences compared; until this is done it would be futile to proceed much further in seeking a theoretical explanation.

Educational Problems.

The average children of player owners will not wish to spend much time in acquiring manual dexterity with scales and five-finger exercises. In place of the present "practising," they will practise exercises in player manipulation, and begin by learning the meaning of the expression marks on the roll. The exercises will be mainly devoted to:—

(1) The control of the speed regulator and the acquisition of the subconscious or instinctive faculty of playing every note or chord at the desired instant. Practice in accompanying.

(2) The production of differences of expression and touch, including those described in this lecture, and the acquisition of the power of accenting parts of chords in any part of the scale. The pupil must not be satisfied until he has learned the exact action corresponding to every note on the keyboard. For school practice automatic accent perforations and separation of bass and treble halves must be forbidden. A school prize should be given for the best rendering of some composition.

The pupils will, however, require some familiarity with the structure of music, and musical notation. For this purpose there will be needed a scale to be placed in front of the tracker showing the black and white notes, and in addition special rolls marked in such a way as to illustrate:—

(1) The rulings of the treble and bass clef in the ordinary staff notation.

(2) The relative value of semibreves, minims, crotchets, quavers, etc., and the corresponding rests.

(3) The distribution of the sharps and flats in different keys.

(4) The meaning of such terms as staccato, legato, arpeggio, trills, etc.

(5) The lengths of the various musical intervals, such as major third and minor fifth.

Finally, in order to acquire practice in reading music, the pupils may learn to cut their own music rolls. Appliances for this purpose are already obtainable, and will doubtless become common in the future. A school class in roll cutting should prove an efficient form of manual training, and prizes could be given for the best cut roll.

NOTE 1.—Owing to the war, I have dropped an application for a German patent, which was made several months previously to its outbreak. Still, I think it desirable that readers of NATURE should see the following criticism by the examiner of the Patent Office at Berlin.

"Owing to the replacement (which is very obvious) of the customary springs by weights, the action of the regulating bellows cannot be improved, but only made worse, since the action will not take place more rapidly but more slowly."

This objection shows the absurdity of placing important decisions regarding the validity of patents, and equally important other matters in the hands of officials who are not in touch with the actual facts of the case. In this case the patent examiner's decision is not backed up either by experimental evidence or by exact mathematical investigations, and his decision is just what might be expected in the circumstances, but is, none the less, hopelessly in error. As a matter of fact—

(1) My experiments prove conclusively that the action of the regulating bellows, instead of being "*made worse*," is greatly "*improved by the replacement of springs by weights.*" That this effect is not "*very obvious*" is shown by the fact that the examiner has conspicuously failed to realise its advantages.

(2) My experiments can only be explained on the hypothesis that "*on account of the necessary accelerations of the weights, the action will not take place more rapidly but more slowly,*" and that this retardation is proved experimentally to give greatly improved results, even though this conclusion is contrary to our preconceived opinions.

No doubt arguments similar to those raised by the German Patent Office would naturally be raised by anyone who had not tested the question by actual experience. But if these objections give any clue to the extent to which the modern piano-player has been perfected up to the present time by German inventions accepted by the Berlin Patent Office, the results must be regarded as hopeless failures.

NOTE 2.—The differences of tone quality produced by differences of touch in my experiments would appear to be identical with those obtained by finger playing which are largely responsible for the success of Prof. Tobias Mathay's pianoforte school. It would, however, appear that some pianos are incapable of exhibiting these differences, and Prof. Mathay unfortunately found when it was too late that the piano kindly lent for the lecture was defective in this respect. I have since tested another player-piano and found an absolute constancy of tone quality, whether played manually or pneumatically.

SCIENTIFIC WORK OF THE SMITHSONIAN INSTITUTION.[1]

Researches and Explorations.

DURING the year the institution continued to carry on investigations in various lines throughout the world by means of small allotments from its funds. It also accomplished a great deal in the way of exploration and research through the generosity of friends of the institution, who contributed funds for special work or provided opportunities for participation in explorations which they had undertaken personally or through the aid of others. Each year, however, the institution is obliged to forgo opportunities for important investigations through lack of sufficient funds.

The Langley Aerodynamical Laboratory.

On May 1, 1913, the secretary was authorised to re-open the Smithsonian Institution laboratory for the study of aerodynamics, and in future it was to be known as the Langley Aerodynamical Laboratory. The functions of the laboratory were defined to be the study of the problems of aerodromics, particularly those of aerodynamics, with such research and experimentation as may be necessary to increase the safety and effectiveness of aerial locomotion for the purposes of commerce, national defence, and the welfare of man.

The first year's work of the laboratory was to arrange a comprehensive programme of operations, devise ways and means of carrying on investigations and publishing reports, conduct such active experiments as were possible with the means immediately available, and to secure and arrange in the library the best aeronautical literature.

The first technical publication sets forth the results of experiments made at the model tank at the Washington Navy Yard. Another report describes the organisation and equipment of the leading aeronautical laboratories of England, France, and Germany. Some of the reports of the committee are as yet confidential or incomplete. The library has been furnished with the chief aeronautic periodicals and the best books thus far published.

The rehabilitation and successful launching of the Langley aeroplane (called "aerodrome" by Prof. Langley), constructed more than a decade ago, was accomplished in May, 1914. The machine was shipped from the Langley Laboratory to the Curtiss aeroplane factory in April. It was re-canvassed and provided with hydroaeroplane floats, and was launched on Lake Keuka on May 28. With Mr. Glenn H. Curtiss as pilot it ran easily over the water, rose on level wing, and flew in steady poise 150 ft. Subsequent short flights were made in order to secure photographs of the craft in the air. Then Mr. Curtiss was authorised, in order to make prolonged flights without overtaxing the bearings of the Langley propulsion fixtures, to instal in its place a standard Curtiss motor and propeller. At the close of the fiscal year the experiments were still making satisfactory progress.

The tests thus far made have shown that the late Secretary Langley had succeeded in building the first aeroplane capable of sustained free flight with a man. It is hoped that further trials will disclose the advantages of the Langley type of machine. It may be recalled that this man-carrying aeroplane was begun in 1898 for the War Department, and in the interest of the national defence. It was built on the design of the model machine which, on May 6, 1896, first demonstrated to the world that an aeroplane heavier than air could be propelled through the air by its own power. The large machine was completed in 1903, but its actual flight was at that time hindered by injuries sustained through defects in the launching apparatus.

Geological Explorations in the Canadian Rockies.

In continuation of his previous geological researches in the Canadian Rockies, Dr. C. A. Walcott, the secretary of the institution, revisited during the field season of 1913 the Robson Peak district, in British Columbia and Alberta, and the region about Field, British Columbia.

On this trip Robson Peak was approached from the west side in order to study the local geological section, one of the finest in the world. Owing to exceptionally good climatic conditions the season of 1913

[1] Abridged from the Report of the Secretary of the Smithsonian Institution for the year ending June 30, 1914.

proved unusually favourable for studying Robson Peak. Frequently in the early morning the details of the snow slopes and bedded rocks on the summit of the peak were beautifully outlined, but toward evening the mists, driven in from the warm currents of the Pacific, 300 miles away, shrouded the mountain from view.

From the west slopes of Titkana Peak, east of the great Hunga Glacier, a wonderful view is obtained of the snow fields and falling glaciers east and north of Robson Peak. The glacial streams come tumbling down the slopes and often disappear beneath the glacier to reappear at its foot with the volume of a river.

At Field, British Columbia, work was continued at the great Middle Cambrian fossil quarry, where a large collection of specimens was secured. It was necessary to do much heavy blasting to reach the finest fossils which occur in the lower layers of rock.

FIG. 1.—Langley man-carrying aerodrome (built 1898-1903) equipped with floats, in flight over Lake Keuka, Hammondsport, N.Y., June 2, 1914.

The collection of 1913 contains a number of very important additions to this ancient fauna and many fine specimens of species found in 1912. A report on these collections is now in preparation.

Geologic History of the Appalachian Valley in Maryland.

Dr. R. S. Bassler, of the National Museum, spent a month during the summer of 1913 in the Appalachian Valley of Maryland and the adjoining States, studying the post-Palæozoic geologic history of the region, as indicated by the present surface features. Since Carboniferous times western Maryland has been above the sea, and its rocks have accordingly been subjected to a long period of aerial erosion. During Jurassic time the area remained stationary for so long a period that the surface of the land in the Appalachian province was reduced to a rolling plain. Later uplift raised this plain still higher above sea-level, and in Maryland only remnants of the old surface are preserved in the flat sky line of the highest mountains. This ancient plain, or Schooley peneplain, as it is termed, is well preserved on the top of the Blue Ridge.

A second great period of erosion occurred in early Tertiary times, the effects of which were chiefly in the Appalachian Valley proper, where the erosion is indicated by a pronounced plain at an elevation of about 750 ft. This plain was formed only on the softer Palæozoic rocks, and, because of its prominence near Harrisburg, Pa., is known as the Harrisburg peneplain. Conococheague Creek traverses the Harrisburg peneplain in Maryland, and has dissected it considerably, but even the sky line of the ancient plain is still clearly evident.

Other factors in the geologic history of Maryland are recorded in the well-defined gravel terraces along the major streams of the area and in great alluvial fans of large and small boulders, spreading out at the foot of the larger mountains and sometimes reaching a depth of 150 ft.

Pleistocene Cave Deposit in Maryland.

As the results of a further examination of the Pleistocene cave deposit near Cumberland, Md., by Mr. J. W. Gidley, of the National Museum, many new forms were added to the collection, and much better material obtained of several species represented only by fragments of jaws in the first collection. The series now includes more than 300 specimens, representing at least forty distinct species of mammals, many of which are extinct. Among the better preserved specimens are several nearly complete skulls and lower jaws. The more important animals represented are two species of bears, two species of a large extinct peccary, a wolverine, a badger, a martin, two porcupines, a woodchuck, and the American eland-like antelope. Other species represented by more fragmentary material include the mastodon, tapir, horse, and beaver, besides several species of the smaller rodents, shrews, bats, and others. This strange assemblage of fossil remains occurs hopelessly intermingled and comparatively thickly scattered through a more or less unevenly hardened mass of cave clays and breccias, which completely filled one or more small chambers of a limestone cave, the material, together with the bones, evidently having come to their final resting place through an ancient opening at the surface of a hundred feet or more above their present location

Geological Survey of Panama.

Last year an allotment was made from the institution's funds toward the expenses of an investigation of the geology of Panama. The general plan includes a systematic study of the physiography, stratigraphy, and structural geology, geologic history, geologic correlation, mineral resources (including coal, oil, and other fields), petrography and palæontology of the Canal Zone, and of as much of the adjacent areas of the Isthmian region as is feasible.

Upon the completion of the work the institution will print a general account of the results, and later there will be published a detailed report of the geological data of the Isthmus and adjoining regions.

Vertebrate Fossil Remains in Montana.

During the summer of 1913 Mr. Charles W. Gilmore, of the National Museum, headed an expedition for the purpose of obtaining a representative collection from north-western Montana. Between 500 and 600 separate fossil bones were obtained, many of them of large size. The most notable discovery was a new Ceratopsian or horned dinosaur, the smallest of its kind known. There were portions of five individuals of this animal recovered, representing nearly all parts of the skeleton, making it possible to mount a composite skeleton for exhibition. Although Ceratopsian fossils were first discovered in the Rocky Mountain region in 1855, and portions of a hundred or more skeletons have been collected, this is the first individual to be found having a complete articulated tail and hind foot. It thus contributes greatly to our knowledge of the skeletal anatomy of this interesting group of extinct reptiles. Another find was a partial skeleton of one of the Trachodont or duck-billed dinosaurs recently described from specimens obtained in Canada, and its discovery in Montana greatly extends its known geographical and geological range. Less perfect skeletons of carnivorous and armoured dinosaurs, turtles, crocodiles, and ganoid fishes were also obtained.

FIG. 2.—Langley man-carrying aerodrome (built 1898–1903) equipped with floats, in flight over Lake Keuka, Hammondsport, N.Y., June 2, 1914.

Life Zones in the Alps.

Dr. Stejneger, head curator of biology in the National Museum, visited the eastern Alps towards the close of the last fiscal year, to make further observations toward a determination of the limits of the life zones, which in that part of Europe might correspond to those established in North America. That a system of such life zones exists in Europe has long been more or less vaguely stated by authors, but although a definite correlation was established by Dr. Stejneger and Mr. Miller in 1904, certain points, especially the interrelation of the zones corresponding to the so-called Canadian and Hudsonian life zones in America, were greatly obscured by the long-continued interference of man and animals with nature, such as the grazing of cattle in the high Alps, deforestation, and, more recently, artificial reafforestation. It was thought that the eastern Alps might show more primitive conditions. Dr. Stejneger visited the mountain region between Switzerland and the head of the Adriatic. Arrived at the town of Bassano, at the foot of the Venetian Alps, he began to study the life zones of the Val Sugana and the plateau of the Sette Comuni from that point. He made a series of excursions from Bassano, Levico, and Trento as successive headquarters. He was able to trace the boundaries of the Austral life zones in considerable detail, as well as to gather data which connect with the previous correlation of these zones in the western Alps and with the corresponding zones in North America. It was found that the bottom of the entire Val Sugana belongs to the upper Austral zone.

Researches under Harriman Trust Fund.

Dr. C. Hart Merriam continued during the year to carry on certain natural history and ethnological investigations provided for by a special trust fund established by Mrs. E. H. Harriman for that purpose. His principal work during the year was on the big bears of America. In furtherance of this study, specimens have been placed at his disposal by numerous sportsmen and hunters and by the larger museums of the United States and Canada. In the course of his investigations a transcontinental line was run across the country to the coast of California by which the easternmost limits of range were determined for a number of species of mammals, birds, reptiles, and plants. And while traversing Utah and Nevada several remote tribes of Indians were visited, particularly the Gosinte, from whom a long-needed vocabulary was obtained.

Anthropological Research in Eastern Asia.

For the extension of researches in eastern Asia, in continuation of anthropological investigations carried on in Siberia and Mongolia under the direction of the institution in 1912, an allotment has been made from the Smithsonian fund for work during the next fiscal year and for a limited period thereafter. The plan of operations includes a thorough study of the peoples of the eastern coast of Asia, Manchuria, Mongolia, Tibet, and Siberia, among whom it is believed lies the secret of the origin of the American Indian. Investigations thus far made by Dr. Hrdlička on behalf of the institution indicate, he says, "that there exist to-day over large parts of eastern Siberia and in Mongolia, Tibet, and other regions in that part of the world numerous remains which now form constituent parts of more modern tribes or nations, of a more ancient population (related in origin, perhaps, with the latest Palæolithic European), which were physically identical with, and in all probability gave rise to, the American Indian."

Researches under the Hodgkins Fund.

The Hodgkins fund was established in 1891 by a gift of 40,000*l.* from Mr. T. G. Hodgkins. By subsequent gifts the fund has increased to about 50,000*l.* It was stipulated by the donor that the income of 20,000*l.* of his gift should be devoted to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man He indicated his desire that researches be not limited to sanitary science, but that the atmosphere be considered in its widest relationship to all branches of science, referring to the experiments of Franklin in atmospheric electricity and the discovery of Paul Bert in regard to the influence of oxygen on the phenomena of vitality as germane to his foundation. To stimulate researches in these directions the institution offered a prize of 2000*l.* for a paper embodying some new and important discovery in regard to the nature and properties of atmospheric air, which was awarded in 1895 to Lord Rayleigh and Sir William Ramsay, of London, for the discovery of argon, a new element in the atmosphere. Another prize of 200*l.* for the best popular treatise on atmospheric air was awarded to Dr. H. de Varigny, of Paris. Numerous investigations on the "composition of expired air and its effects upon animal life," in "atmospheric actinometry," the "air of towns," "animal resistance to disease," "experiments with ionised air," "the ratio of specific heats," and kindred topics have been carried on with the aid of grants from the Hodgkins fund. Researches have likewise been aided in connection with the temperature, pressure, radiation, and other features of the atmosphere at very high altitudes, extending during the past year to more than 45,000 feet, and many other lines of investigation have been carried on, through all of which it is believed that valuable knowledge has been acquired by which the welfare of man has been advanced.

Under a grant from the Hodgkins fund Mr. A. K. Ångström carried on some observations in California during the year for the purpose of measuring nocturnal radiations at different altitudes ranging from below sea-level to the summit of Mount Whitney, 4420 metres (14,502 ft.).

A grant was also made to Mr. Ångström to enable him to measure the "nocturnal radiation"—that is, loss of heat to space during the total eclipse of the sun, August 21, 1914, in the north of Sweden.

In connection with the International Congress on Tuberculosis held in the National Museum in 1908, the institution offered a Hodgkins fund prize of 300*l.* for the best treatise on "the relation of atmospheric air to tuberculosis." The prize was divided equally between Dr. Guy Hinsdale, of Hot Springs, Va., and Dr. S. Adolphus Knopf, of New York, for their essays.

Research Corporation.

In February, 1912, the Research Corporation was organised under the laws of New York as a means for furthering scientific and technical research. Its principal object is—to acquire inventions and patents and to make them more available in the arts and industries, while using them as a source of income, and, second, to apply all profits derived from such use to the advance of technical and scientific investigation and experimentation through the agency of the Smithsonian Institution and such other scientific and educational institutions and societies as may be selected by the directors.

The Smithsonian Institution is interested in the management of this corporation through the membership of the secretary in its board of directors. The chief assets of the corporation at present are the Cottrell patents relating to the precipitation of dust, smoke, and chemical fumes by the use of electrical currents. A number of other patents in various fields of industry have been offered by officers of the Government and scientific institutions, as well as by manufacturing corporations holding patents not available for their own purposes, and undoubtedly there are many others, both in this country and abroad, who will be glad to have their inventions utilised for the benefit of scientific research.

National Museum.

The growth of the museum during recent years has been greater than during any prior period of its history. The natural history collections are now given adequate room in the spacious halls of the new building. Increase in every division of the three principal departments of the museum—anthropology, biology, and geology—is now welcomed both for purposes of exhibition and in the study series.

Bureau of American Ethnology.

The work of the Bureau of American Ethnology during the year has brought together much new material relating to the habits and customs and the languages of the American Indians. One of special interest was a reconnaissance by Mr. F. W. Hodge, ethnologist-in-charge, of a group of prehistoric ruins on a mesa in Cebollita Valley, N. Mex. These ruins consist of a number of house groups forming a compound built on an almost impregnable height, and designed for defence; not only the groups but the individual houses have the form of fortifications, while the vulnerable point of the mesa rim is protected by means of a rude breastwork of stones. Among the special features of interest which Mr. Hodge discovered were a burial cist in which skeletons, pottery, and the remains of a mat were found; three small cliff lodges situated in the sides of the cliffs; several ceremonial rooms or kivas associated with the ruined houses; and the remains of the early reservoirs of the inhabitants.

National Zoological Park.

The collection in the park is the outgrowth of a small number of living animals which for several years had been assembled in very crowded quarters near the Smithsonian building, mainly for the purposes of scientific study. Chiefly through gifts and exchanges the size of the park collection has gradually increased, until it now numbers 340 species of mammals, birds, and reptiles, represented by 1362 individuals.

Astrophysical Observatory.

The work of the Astrophysical Observatory has comprised observations and computations at Washington and in the field relating to the quantity of solar radiation, its variability from day to day, and the effect of the atmospheric water vapour in absorbing the radiations of great wave-length such as are emitted toward space by the earth. Much attention has been given to the design, construction, and testing of new apparatus for these researches, including apparatus for measuring the sky radiation, special recording pyrheliometers to be attached to free balloons for the purpose of measuring solar radiation at great altitudes, and a tower telescope at the Mount Wilson Station.

The principal results of the year include: a new determination of the number of molecules per cubic centimetre of gas, depending on measurements at Mount Wilson of the transparency of the atmosphere; successful measurements by balloon pyrheliometers of the intensity of solar radiation up to nearly 45,000 ft. elevation above sea-level. The results tend to confirm the adopted value of the solar constant of radiation. Most important of all, the investigation by the tower telescope at Mount Wilson shows that the distribution of radiation along the diameter of the sun's disc varies from day to day and from year to year. These variations are closely correlated with the variations of the total amount of the sun's radiation. Thus the work of the year yields an independent proof of the variability of the sun and tends to elucidate its nature.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Birmingham.—Dr. Douglas Stanley has been appointed to the chair of therapeutics.

Dr. L. G. Parsons has been appointed to the newly created lectureship in infant hygiene and diseases peculiar to children.

Dr. C. K. Tinkler is resigning his post as lecturer in chemistry on his appointment to the London University readership in chemistry in the department of home science at King's College.

Cambridge.—An exhibition of 50*l.* a year tenable for two years is offered each year by the governing body of Emmanuel College to a research student commencing residence at Cambridge as a member of Emmanuel College in October. The governing body may award additional exhibitions of smaller value should properly qualified applicants present themselves. The exhibitions will be awarded at the beginning of October. Applications, accompanied by two certificates of good character, should be sent to the Master of Emmanuel not later than September 24.

It is stated in the issue of *Science* for March 12 that the Massachusetts Committee on Education voted unanimously on February 25 in favour of "taking initial steps toward the establishment of a State university."

Dr. F. J. Goodnow will be formally inaugurated president of the Johns Hopkins University on or about May 20. According to *Science* it has been arranged to give the occasion a double significance, for, in addition to the inauguration of the third president of the University, the new site at Homewood is to be dedicated formally.

The scientific advisory committee of the University of Sheffield has recently held, on March 18, 19, and 20, an exhibition of British-made laboratory apparatus and material, with the double object of acquainting consumers with sources of supply, and of obtaining support for the new industries so as to enable them to become permanently established. The exhibits included glass and porcelain ware of different kinds and different sources of manufacture, glass wool, transparent and opaque silica ware, acid-resisting metals, filter papers, and a variety of clay goods. The exhibition aroused considerable interest in Sheffield and the neighbourhood, and great satisfaction was expressed by visitors at the progress which the manufacture of laboratory ware has made in this country in the period since the war began.

The Board of Education has published a "Memorandum on the Teaching of Engineering in Evening Technical Schools" (Circular 894, price 6*d.*). Its object is to furnish suggestions to teachers and organisers of schools which provide evening classes in mechanical and electrical engineering, and not to lay down a scheme of instruction suitable for universal application. The need for a great variety both in methods and organisation, to meet the needs of students working in different areas under special industrial conditions, is borne in mind throughout. Part-time courses only are considered in the memorandum, and such subjects are dealt with as the classification of the courses, suitable curricula, and the outlines of laboratory and class work. The detailed outlines of work for courses in mechanical and electrical engineering to suit students of different grades will provide teachers with practical help in modifying and improving their own syllabuses of instruction.

The annual report of the University College, London, Committee shows that the total number of students for the session 1913–14 was 2206, including in the faculty of science 148 men and 50 women; in the faculty of medical sciences, 138 men; in the faculty of engineering, 134 men; post-graduate and research students, 313 men, 128 women. Of evening students there were in the faculty of science 22 men, 29 women. For the current session, 1914–15, owing to the war, there has been a decline in the total number of 335, the decline in full-time students up to the present date being 462. The fall in numbers will involve a decrease in fees of not less than 10,000*l*. The "Pro Patria" list already issued contains 665 names, distributed as follows:—Army, 523; Navy, 30; Officers Training Corps, 69; Red Cross work, already abroad, 17; voluntary aid detachment, ready for service, 26. A large number of refugee students has been received, each student paying a nominal fee. The number admitted since the beginning of the session has been 116; at the opening of the second term, the number actually at work was 81. The college staff, with the help of its friends, has provided hospitality for about forty-eight persons, and has raised a sum of nearly 300*l*. to aid the students. The revenue of the college in 1913–14 was 71,567*l*., the expenditure 71,260*l*. Members of the college have already indicated their willingness to assist in helping towards the deficit created by the war. The completion of the new buildings has been delayed by the war. A special effort on the part of the Equipment and Endowment Fund Committee is to be made to raise the remainder of the sum necessary for the completion of the chemical laboratories. The sum still needed for this purpose is 13,650*l*., the greater part of which (10,000*l*) is required for the special equipment of a physical and electrical chemistry laboratory. The national need of improved facilities for chemical education emphasises the desirability of completing the equipment of these new laboratories.

SOCIETIES AND ACADEMIES.

London.

Mineralogical Society, March 16.—Dr. A. E. H. Tutton, president, in the chair.—Prof. G. **Cesàro**: Orpiment from Balia, Asia Minor. Results of a crystallographic examination were given.—Prof. G. **Cesàro**: Stereographic projection of a cone touching the sphere of projection along a small circle.—Dr. S. **Kôzu**: The dispersion of adularia from St. Gothard, felspar from Madagascar, and moonstone from Ceylon. A second communication giving the results of careful measurements.—Dr. G. T. **Prior**: The meteoric stone of Launton, Oxfordshire. The stone, which was seen to fall on February 15, 1830, was acquired by Dr. Lee and placed in his natural history collection at Hartwell House, near Aylesbury. After his death it was, through confusion with another meteorite, lost sight of until 1895, when it was found by Dr. Fletcher wrongly labelled in the Lee collection, and was secured for the British Museum. The stone belongs to the white-veined chondrite group, and in chemical and mineral composition agrees with other members of that group.

Linnean Society, March 18.—Prof. E. B. Poulton, president, in the chair.—J. A. **Wheldon** and W. G. **Travis**: The lichens of South Lancashire. In the introductory part of their paper, the authors, after referring to the enormous industrial development and increase of population which took place in South Lancashire during the last century, point out the deterioration of the flora which ensued, and then proceed to detail the results of their study of the effects of air-pollution by coal-smoke on the cryptogamic vegetation, and more particularly on lichen-growth. They are of opinion that South Lancashire exhibits the deleterious effects of smoke on vegetation to a higher degree over a larger area than is, perhaps, the case in any other part of Great Britain. They think, however, that these adverse conditions have now reached their maximum. It has, therefore, been considered of importance exactly to describe the state of the lichen-flora as it at present exists, so that data may be afforded for purposes of comparison at some future time when a regenerated lichen-flora has developed under purer atmospheric conditions. The authors show the extent to which the various classes of lichens, more especially those of corticolous and rupestral habitats, have suffered; and in this connection the marked influence of a calcareous substratum in neutralising the deleterious effects of smoke on lichen-growth is discussed. Particular attention has been paid by the authors to the lichens of the coast sand-dunes, the lichens of the Sand-dune Plant Formation in Britain not having hitherto been specially investigated. The characteristic lichens of these dunes and their ecological relations are described. A systematic list of all species of lichens found in the vice-county is given; and four new species and two new varieties are described.

Manchester.

Literary and Philosophical Society, February 23.—Mr. F. Nicholson, president, in the chair.—Prof. W. W. Haldane **Gee**: A projection screen invented by the late Mr. Thomas Thorp. The screen is made by producing a special type of matt surface on glass, on which is then deposited silver. This forms the opaque back of the screen, the front being of transparent glass. The screen gives a well-illuminated picture when employed for ordinary lantern work, and is especially good for use with the projecting microscope. By its means the Brownian motion of colloidal particles, which requires high magnification and great loss of light, can be demonstrated. The screen is most effective when viewed at an angle nearly perpendicular to its surface. A microscopic examination of the surface shows that it is made up of minute convex discs.—Prof. G. Elliot **Smith**: The significance of the geographical distribution of the practice of mummification. Mummification is the most distinctive element of a complexly-interwoven series of peculiar customs, including the practice of building megalithic monuments, sun- and serpent-worship, circumcision, tattooing, etc. The art of embalming certainly originated in Egypt, and, as the practice is of a nature extremely repulsive to mankind, the circumstances must have been of quite an exceptional nature to have driven any people to adopt such a custom. It is altogether unlikely that such a complex combination of special circumstances as we know to have called the practice into existence in Egypt should have arisen in more than one place. The details of the technique, in whatever part of the world the custom is found, emphasise an Egyptian origin. The practice spread from Egypt to the Mediterranean littoral, Europe, and the Canary Islands; to East Africa, Upper Congo, Southern Nigeria; to the Persian Gulf, India, Ceylon, Burma, Indonesia, New Guinea, the islands of the Torres Straits, and thence to Australia. Emigrants from Indonesia carried it to Tonga, New Zealand, Tahiti, and eventually to the Peruvian coast of South America.

Paris.

Academy of Sciences, March 15.—M. Ed. Perrier in the chair.—René **Garnier**: A class of Abelian systems deduced from the theory of linear equations.—Victor **Vâlcovici**: The theorem of movements of quantities of motion.—A. Le **Bel**: Researches on the catathermic radiation. Experiments on the hypothetical radiation suggested by Tissot.—A. **Leduc**: The ratio γ of the two specific heats of mixtures of gases. Applications. A formula is deduced for the ratio of the two specific heats of gas mixtures based on expressions given by the author in earlier papers, and it is shown that the results are appreciably different from those calculated from the usual method of averages.—Léon **Bloch**: The absorption of gases by resonance.—A. **Portevin**:

The mechanical anisotropy of metals and alloys of coarse grain.—F. de Montessus de **Ballore**: The seismogenic influence of parallel faults.—Pereira de **Sousa**: The macroseisms of 1911, 1912, 1913, 1914, in the north of Portugal. The earthquakes in the north of Portugal (Minho) from 1911 to 1914 were of epirogenic origin. Their maximum intensity was shown along the seismotectonic line Paços de Ferreira-Vila Nova de Famalicão-Barcellos-Caminha, and their maximum extension along the seismotectonic line Vila do Conde-Malta-Gondomar.—G. **Arnaud**: The roots of gummy beetroots. The gummy degeneration of the beetroot, which has been rather marked this winter, is shown to be caused by a bacterium, the isolation and description of which are described.—P. **Carnot** and B. **Weill-Hallé**: The dissemination of the typhoid bacillus round patients attacked with the disease. A study of the various types of typhoid carriers, with some practical recommendations, including the necessity for the prolonged isolation of typhoid patients, rigorous disinfection of the wards and of infected articles, and semi-isolation and hyper-vaccination of the hospital staff.—Maurice **Piettre**: The feeding of armies in the field. A statement of the advantages connected with the use of preserved vegetables.

March 22.—M. Ed. Perrier in the chair.—Paul **Brück**: First elements of the Mellish comet. Based on an observation on February 15 made at Taschkent Observatory, and two observations by M. Coggia made on February 20 and 25.—Emile **Saillard**: The estimation of saccharose in beetroot after freezing and thawing. A considerable proportion of the saccharose has disappeared by a viscous fermentation.—Louis **Rousseau**: Crystallised calcium theobrominate. Lime water and theobromine react at the boiling point forming a crystallised compound which, on analysis, proved to have the composition $(C_7H_7N_4O_2)_2Ca,9H_2O$. The properties of this compound are detailed.—Maurice **Lugeon** and Gerhard **Henny**: The alpino-dinaric limit in the neighbourhood of the massif of Adamello.—Henry **Hubert**: Anomalies in the distribution of the temperature curves in western Africa.—Julien **Loisel**: a representative nomogram of the psychrometric formula.—M. **Pavillard**: Increase and scissiparity in the Peridineans.—J. **Basset**: Preserved food for the armies in the field. Modifications of the existing ration are suggested with a view of giving greater variety of food.—H. **Vincent**: Experimental vaccination against the cholera bacillus by a vaccine sterilised with ether. The advantages of the use of ether are the rapid sterilisation, reduction in the amounts of useless lipoid bodies, and the dissociation of the treated bacilli favourable to their rapid bacteriolysis in glass and their rapid resorption in the body.—Ch. J. **Gravier**: The biology of corals from great oceanic depths.

BOOKS RECEIVED.

The Works of Aristotle, translated into English: De Mundo. By E. S. Forster. De Spiritu. By Prof. J. F. Dobson. (Oxford: At the Clarendon Press.) 2*s.* net.

The Works of Aristotle, translated into English: Magna Moralia. By St. George Stock. Ethica Eudemia. De Virtutibus et Vitiis. By J. Solomon. (Oxford: At the Clarendon Press.) 5*s.* net.

Principles of Physical Geography. By G. C. Fry. Pp. x+151. (London: W. B. Clive.) 1*s.* 6*d.*

First Principles of Production. By J. T. Peddie. Pp. 231. (London: Longmans and Co.) 5*s.* net.

Modern Illuminants and Illuminating Engineering. By L. Gaster and J. S. Dow. Pp. xiv+462. (London: Whittaker and Co.) 12*s.* 6*d.* net.

Essays towards a Theory of Knowledge. By A. Philip. Pp. 126. (London: G. Routledge and Sons, Ltd.) 2*s.* 6*d.* net.

"Rain and Rivers." The Rev. Prof. Bonney and the late Col. George Greenwood. Pp. 16. (London: Watts and Co.) 3*d.*

Board of Education. Memorandum on the Teaching of Engineering in Evening Technical Schools. Pp. 59. (London: H.M.S.O.; Wyman and Sons, Ltd.) 6*d.*

A History of the Royal Dublin Society. By Dr. H. F. Berry. Pp. xv+460. (London: Longmans and Co.) 15*s.* net.

The Problem of Volcanism. By Dr. J. P. Iddings. Pp. xvi+273. (New Haven: Yale University Press; Oxford: University Press.) 21*s.* net.

Œdema and Nephritis. By Dr. M. H. Fischer. Second edition. Pp. x+695. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s.* net.

DIARY OF SOCIETIES.

WEDNESDAY, April 7.

Entomological Society, at 8.

FRIDAY, April 9.

Royal Astronomical Society, at 5.

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THURSDAY, APRIL 8, 1915.

THE COMPLETE WORKS OF TYCHO BRAHE.

Tychonis Brahe Dani Opera Omnia. Edidit I. L. E. Dreyer. Tomus I. Pp. lix+320. (Copenhagen: Gyldendalske Boghandel Nordisk Forlag, 1913.)

PERHAPS one's first sensation on handling this beautiful volume is one of surprise that three centuries have been allowed to pass after Tycho's death before his writings were given to the world in a collected form; for he took a notable part in building the structure of modern astronomy. He was the first to realise the imperfections of the existing solar and planetary tables, and the fact that their improvement needed prolonged observations with larger and more carefully designed instruments than any that had yet been employed; he fortunately had the skill to design these, and the means to purchase them. Thanks to the bounty of Frederick II., he was enabled to found Uraniborg Observatory, where sun, moon, planets, and stars were observed assiduously for twenty years.

The planetary observations led Kepler to the enunciation of his three laws, those of the moon led Tycho himself to detect the variation and annual equation, also the oscillatory changes of the node and inclination; those of the sun led to the detection of atmospheric refraction, and an approximate measure of its amount. Those of comets showed, by the minuteness of their diurnal parallax, that they were much more remote than the moon, and hence that they were not vapours in our own atmosphere, as many had supposed, but belonged to the planetary sphere. His observations of the fixed stars were far more precise than any previous ones, so that according to Dr. Dreyer the probable error of his standard right ascensions is only 24″; thus we may reasonably conjecture that if Tycho had lived a few years later, and known of the telescopic method, his results might be of utility even in our day.

The present reprint is under the auspices of "Det Danske Spreg og Litteratur Selskab," which has been fortunate in securing the services of Dr. Dreyer as editor. The task is evidently a labour of love with him, as he has made a special study of Tycho's life, having written his biography in 1890; he has written a Latin preface of fifty-nine pages in the present work, giving a biographical outline and a summary of the astronomical achievements; the fuller biography should however, be read by all serious students of his life.

Mr. G. A. Hagemann is generously bearing the cost of the publication of the collected works, which must be considerable, as it is being carried out in a sumptuous manner, with very large, clear type on thick, strong paper, and will run into several volumes.

The heavens themselves signalised in a brilliant manner the advent of Tycho by the outburst of Nova Cassiopeiae in 1572. The memoir, "De Nova Stella," was the first of his published writings, and appropriately begins the collection. "Last year, on the evening of November 11, while contemplating the stars, according to my custom, I observed a new, remarkably bright one nearly overhead. And since from my boyhood all the stars were perfectly familiar to me (such knowledge is not difficult to acquire) it was certain that there had not been even a faint one in that position, much less one of surpassing splendour." Mistrusting his own eyes, he quickly got his neighbours to verify the discovery, which appeared more startling to him than to us, since he knew of no parallel except the star of Hipparchus.

He diligently observed the position of the Nova at various hour-angles, and after some months' observation satisfied himself that it had neither proper motion nor diurnal parallax (on his geocentric hypothesis annual parallax was not to be expected), so he rightly concluded that it belonged to the sphere of the fixed stars; the fact that it scintillated confirmed this view. He estimated its bulk as many hundred times that of the earth, no doubt thinking himself very daring.

His notes on the magnitude and colour are interesting, to compare with those on modern Novæ. In November, 1572, the Nova was much brighter than Venus, so that many people saw it in full daylight; at that time its colour was compared to that of Jupiter. The brightness in December was equal to Jupiter, in February and March to a star of the first magnitude, in May to one of the second. The colour became red like Mars or Aldebaran; later still it became livid like Saturn.

The astrological significance of the Nova is fully discussed; Tycho made some lucky hits; in the next century many people saw in the career of Gustavus Adolphus a striking fulfilment of the horoscope based on the Nova.

The volume before us also contains the horoscopes of the three sons of Frederick II.: Christian, Ulrich, and Hans. Dr. Dreyer notes that astrology cannot be omitted if we desire to enter fully into the thought of that age, and that Tycho could not refuse to draw up these horoscopes when the king, his patron, requested him to do so. Also, belief in planetary influence seems less unreasonable in the case of those who accept the geocentric hypothesis. Tycho seems to have had some faith in his predictions, but he regarded them rather as warnings of evil tendencies to be resisted, or good ones to be encouraged, than as hard and fast determinations of inevitable destiny. It is rather pathetic to remember that when the eldest prince ascended the throne as Christian IV., he withdrew all Tycho's emoluments, and treated him with such marked coldness that Tycho was glad to leave Denmark altogether, and end his days in exile in Bohemia.

The remaining matter in the volume is an oration on the teaching of mathematics, and a short treatise on practical trigonometry. Tycho had access to seven-figure tables of the natural functions, and made use of the formulæ transforming products of sines and cosines into sums of the same, to save multiplication, logarithms not having been invented.

It is one of the advantages of a verbatim reprint that it satisfies our curiosity on such small matters of procedure, and helps us to realise the everyday life and thought of astronomers of distant ages.

THE RISE AND GROWTH OF BOTANY IN THE UNITED KINGDOM.

A History of Botany in the United Kingdom from the Earliest Times to the End of the Nineteenth Century. By Dr. J. Reynolds Green. Pp. xii + 648. (London: J. M. Dent and Sons, Ltd., 1914.) Price 10*s*. 6*d*. net.

MANY British and Irish botanists have been anticipating the appearance of Prof. Reynolds Green's history of the development of their science within the United Kingdom, but its reception cannot but be accompanied with feelings of sincere regret that the author is no longer with us. Indeed, he was seriously ill during much of its preparation, and one should not lose sight of this while perusing its pages. His friend, Prof. Harvey-Gibson, undertook the duty of seeing the work through the press, though, as he states in an appendix to the preface, he has refrained from editing it in any way.

As anyone who is familiar with Green's writings would be led to expect, the book is well arranged, lucid, and clearly written, and it provides an excellent general description of the rise and development of the science of botany amongst us. Opening with a summary of the work of the old writers of herbals, the book goes on to trace the varied phases of the newer advances, the use of botanic gardens, and the recognition and growth of the subject at the universities; it also discusses the more recent ramifications of botany and its points of contact with kindred sciences. A considerable portion of the volume is devoted to an account of the activities of modern and still living botanists. It is full of generous appreciation of the work of his contemporaries, but Green, with characteristic modesty, is almost silent on his own important contributions to vegetable physiology.

We could wish to give a measure of praise to the book more full than mature reflection enables us to do. It is admirable up to a point, and one must remember the disadvantages under which its author laboured, failing health and severe family bereavement, during its production. Without doubt, had Green been spared to see the whole work through its final stages and up to publication, he would have corrected many of the errors one meets with in its pages. It would be ungracious to dwell on these overmuch, but truth to tell the book stands in some need of revision on the score of historical accuracy, and sometimes also in the matter of names of the writers who are quoted. It is, furthermore, not improbable that there may be some difference of opinion as to the correctness of the general perspective, and as to the insight into the relative importance of the work and powers of more recent botanists.

But when this has been said, we may recognise that Green has left us a book of permanent value —a lively impression of the services to science, as well as of the personalities of a number of his contemporaries. The way in which he has treated this part of his subject shows him as a genial friend; perhaps somewhat apt to overvalue those for whom he entertained feelings of personal affection, but to no one is he either mean or unkind.

J. B. F.

OBJECTIVE PSYCHOLOGY—PURE AND APPLIED.

Objektive Psychologie oder Psychoreflexologie; die Lehre von den Assoziationsreflexen. By Prof. W. von Bechterew. Autorisierte Uebersetzung aus dem Russischen. Pp. viii + 468. (Leipzig and Berlin: B. G. Teubner, 1913.) Price 16 marks.

Psychology and Industrial Efficiency. By Hugo Münsterberg. Pp. xviii + 322. (London: Constable and Co., Ltd., 1913.) Price 6*s*. net.

THESE two books, though widely different in origin and aim, agree in exemplifying a single method of psychological investigation: namely, the method which American writers describe by the ungainly term "behaviourism." It is a psychology in which (to quote Prof. von Bechterew) questions of subjective processes, or processes of consciousness, find no place. The science defined by this exclusion obviously differs widely from the psychology based upon introspection; it may be regarded as an extension into the human field of the methods developed by Lloyd Morgan in his experiments on the instinctive behaviour of chickens, and by other workers who have followed his highly important lead.

(1) The point of view is explained and defended by von Bechterew in the first fifty pages of his volume. As he conceives it, objective psychology is the science of "psycho-reflexes," that is, of the neural mechanisms the activities of which are either known or supposed to be accompanied by psychoses, whether the subject is conscious of them or not. The remainder of the work is a systematic exposition of the results hitherto obtained by the objective methods, from the analysis of the simpler primary and secondary reflexes to that of the complicated forms of behaviour covered by such terms as will. Many of the researches described have been carried out in von Bechterew's own laboratory in Petrograd; those of other workers are summarised with much ability and with copious references to the original sources. The whole argument is, in fact, developed so clearly and is so elaborately documented that even students who do not accept the author's methodological postulates will find in his book a very valuable collection of material, admirably organised.

(2) Prof. Münsterberg's book is directed less to the student than to the educated layman—particularly to the business man who has heard of the remarkable achievements (and still more remarkable claims) of the pioneers in the "scientific management" of industrial processes and desires to know what a competent psychologist has to say upon the subject.

The author shows by a number of interesting examples, largely from his own laboratory, that the psychologist can help the leader of industry in two specific and important ways. In the first place, by submitting candidates for employment to laboratory tests, he can differentiate with confidence between those whose psychophysical outfit is suitable for the work to be done and those who are unlikely ever to become efficient. Among his illustrations Münsterberg describes, in this connection, the ingenious devices he uses to test the capacity of a man to drive an electric car through busy city streets. In the second place, the psychologist can determine the conditions of rapid and effective training in the performance of skilled acts (*e.g.*, typewriting), and the conditions which will secure the most economical use of the trained worker's skill while minimising the deleterious influences of fatigue and monotony.

In both these departments the "psychology of industry" leads directly to social efficiency in both the narrower and the wider sense; for it tends to the increase both of the productivity and of the happiness of the worker. It is difficult to view with equal approval the investigations into the effects of advertisements and the psychology of the shop-counter, though Prof. Münsterberg's studies of these topics have undoubted interest as explorations of human frailty. T. P. N.

ZOOLOGICAL MONOGRAPHS.

(1) *Reptiles and Batrachians.* By E. G. Boulenger. Pp. xiv + 278. (London: J. M. Dent and Sons, Ltd., n.d.) Price 16*s*. net.

(2) *Some South Indian Insects and Other Animals of Importance, considered especially from an economic point of view.* By T. Bainbridge Fletcher. Pp. xxii + 565. (Madras: Government Press, 1914.) Price 9*s*.

(1) THE prominent features of this convenient volume are the notes on habits, and the illustrations—mostly prints of photographs from life taken by Mr. W. S. Berridge in the Zoological Society's Gardens. Comparative anatomy and the general principles of vertebrate zoology do not come within its scope; but a knowledge of these things being taken for granted, the two classes of reptilia and amphibia are surveyed as detached assemblages. Much after the fashion of the best type of museum catalogue, the distinctive characters of every subordinate group of each class are defined, and the geographical distribution of the minor groups determined; and, much after the fashion of the best type of guide-book, the notable species are succinctly characterised and carefully considered as objects of living interest. A vast amount of well-arranged and easily assimilated information is thus presented to the intelligent reader, not only in respect of structural features, taxonomic relations, life-history, habits, range, and mode of life, but also with regard to popular beliefs and native superstitions, economic bearings, and numerous other matters of interest. Beyond this the author, as one of the curators of the Zoological Society's Gardens, has taken every opportunity of recording interesting facts concerning the behaviour, adaptability, and treatment of reptiles and batrachians in captivity, and of noting their peculiarities, preferences, and other interesting phenomena of their growth and being.

Snakes occupy exactly one-third of the book, and the author has done justice to the subject. With regard to venomous snakes, however, he has scarcely made it clear that in order to inject its venom in lethal amount a snake must not only strike but must also grip, so as to drive its poison-fangs home and wring out its glands. And with regard to the treatment of snake-bite, he has failed to impress sufficiently upon his readers the important facts (*a*) that the most efficient ligatures and the most powerful local antidotes are perfectly useless if applied after a lethal dose of venom has been absorbed—the available interval, according to the ample and carefully controlled experiments of Captains H. W. Acton and R. Knowles, being from ten to twenty minutes; and (*b*) that after the venom has been absorbed in lethal quantity the *only* hopeful remedy is a suitable anti-venom.

Good and useful as this book is, it is to be regretted that, like so many modern things, it recks so little of the priceless past. Without going back to Herodotus and his entertaining account of the crocodile, the author might have said something about the great pioneers of herpetology.

(2) This is a book that, notwithstanding the limitations of its title, is of much more than local service. Its contents are disposed in three progressive stages, the first dealing with insects generally from a biological viewpoint, the second treating more particularly of insects in their economic range, while the third is at once an exact survey and an illustrated epitome of the specific local forms that affect man and his works for good and ill, but chiefly for ill.

As is natural in a work sponsored by a director of agriculture and a board of revenue, the main end is economic—namely, to place on record what is known about the insect pests of agriculture in southern India, to facilitate their identification, and to explain approved methods of limiting their ravages. Order by order, and family by family, the specific pests are marshalled and individually figured on a lavish scale, referred to their local habitation, characterised in their life-history and economic *rôle*, and relegated to the code of criminal procedure. Beyond this certain forms concerned in the transmission of disease are treated in a practical manner, and many insects of approved utility or potential service to man are individually noticed and portrayed.

The earlier pages that deal with insects as a class in their broad economic incidence are also well done. Among other things they include good chapters on pests as a whole, the general causes that favour their increase, the various means by which they may spread, and the methods adopted for their control. These last, both direct and indirect, are discussed with insight and discrimination, and insecticides of divers kinds, and all the ingenious apparatus of their application, are fully described and criticised; while at the same time the author is careful to emphasise the rational factor underlying all remedial treatment—namely, exact knowledge not only of the life-history of the particular pest, but also of all the local conditions, natural and otherwise, of its particular occurrence. The series of chapters on economic insects brigaded according to *rôle* or circuit—*e.g.* as caterpillar pests, beneficial insects, pests of stores, and so on—are also extremely useful, such collective unities being easy to follow and to tackle.

The preliminary chapters on insect biology, though rather promiscuous and sketchy, are good in intention and are suggestive. In the chapter on "tropisms," however, the author gives his reader no hint that the subject-matter of his definitions and classification lies on the very boundary-line of legitimate inference and beyond the bounds of exact knowledge, and that these "tropisms" are mere imposing words which not only do not explain any process of nature, but are not even generalised expressions of the results of any analysis of natural processes.

The price of the volume, with its fifty beautiful coloured plates and many hundreds of illustrations in the text, is absurdly low, but its weight (5 lb. 6 oz.) is prodigious.

OUR BOOKSHELF.

Memoirs of the Colombo Museum. Series A., No. 1. *Bronzes from Ceylon, Chiefly in the Colombo Museum.* By Dr. A. K. Coomaraswamy. Pp. 31+xxviii plates. (Ceylon: Colombo Museum, 1914.) n.p.

This is the first issue of a series of monographs intended to describe the art treasures of the Colombo Museum, among which the bronzes are of special importance. Some of the finest examples have been published in Mr. Vincent Smith's "History of Fine Art in India and Ceylon," but a more complete description of these beautiful objects is welcome. Dr. A. K. Coomaraswamy has contributed a useful introduction. It is not easy to fix the exact date of the bronzes, but they seem to cover the period beween the ninth and fourteenth centuries, A.D. They fall into two groups: Buddhist and Saiva Hindu. The discovery in Ceylon of many images of Bodhasattvas and female Mahāyāna deities is important because it proves that the latter cult existed in the island, and that it is now more than ever inaccurate to speak of Northern and Southern Buddhism as if these geographical terms connoted a distinction between the Hīnayāna and Mahāyāna schools. In this connection the images of Brahmanical deities absorbed into Buddhism are of special value.

The Saiva Hindu bronzes, like those from Polonnāruva, differ widely from the Buddhist group: they may have been cast in Ceylon, but as a group they are allied to the school of South India. Their existence may represent a Tamil occupation of the island, but it is possible that both Buddhist and Hindu cults may have been contemporaneous. Siva here is found performing his orgiastic dance, and he is accompanied by his Sakti, or female energy, the Mother of the Universe, source of power and fertility. Finally come the local deities, like Pattini, patron of chastity and guardian of disease, who was a deified woman executed on a false charge of stealing the anklet of the Queen of Madura. The bronzes thus represent a complex of cults: Buddhism, Brahmanical Hinduism, and the worship of local deities, all combined by the eclectic tendencies of modern Hinduism. Those who are interested in Ceylon will welcome the promised publication in this series of monographs on the local archæology, ethnology, and botany.

A Text-book of Practical Assaying, for the use of Mining Schools, Miners, and Metallurgists. By Prof. J. Park. Pp. xii+342. (London: C. Griffin and Co., Ltd., 1914.) Price 7*s.* 6*d.* net.

This capital little book is a welcome addition to the lengthening list of treatises on assaying which are available in this country. It has already appeared in New Zealand, where it has been used for the last ten years as a text-book in many class-rooms. It is arranged as a course of instruction for students, intended to be spread over two years, beginning with the easier operations and gradually leading up to more difficult ones.

The book contains a comprehensive course, and in his zeal for completeness the author towards the end so far diverges from his own definition of assaying as to include the analysis of soils, manures, sugar, and milk. Nevertheless, it must not be assumed that everything is fair game which comes into the net of this well-known professor of mining. There is little which could be omitted with advantage. It will readily be believed, however, that one of the merits of the book is conciseness, and in some sections strength would be gained by expansion and the addition of a few more details, as, for example, in the assay of copper by electrolysis.

The book is also commendable in its accuracy, and it will be prized by students who are familiar with it after they have passed out into the works laboratory.

The directions for arithmetical computation of results are perhaps unnecessarily full and explicit for university students, and such a remark as the following might be omitted:—"Suppose one gramme of copper ore yielded 0·46 gramme of copper, then the percentage is equal to 46." Some other directions in the book are similarly elementary, but teachers of classes in secondary and technical schools will not object to it on that account. For these classes it is an eminently suitable book. A few more illustrations of apparatus would not be amiss.

T. K. R.

New "Acribo" Sectional Pads. Fifty sheets in a pad with cover. (London: W. H. Harling.) Price of each pad, 2*s.* 6*d.*

Mr. Harling's new pads of squared paper are printed in grey with a view to obviate eye strain and to ensure prominence for the curves plotted. Three rulings are available: inches and eighths, inches and tenths, and centimetres and millimetres. The size of the ruled portion of each pad is 10 in. by 8 in. or 26 cm. by 20 cm. The paper is excellent, the ruling is accurate, the pad is convenient, and the production is British throughout.

The Counties of Clackmannan and Kinross. By J. P. Day. Pp. viii+145. (Cambridge: At the University Press, 1915.) Price 1*s.* 6*d.* net.

The Counties of Moray and Nairn. By Charles Matheson. Pp. x+139. (Cambridge: At the University Press, 1915.) Price 1*s.* 6*d.* net.

These recent additions to the series of Cambridge County Geographies maintain the high standard of attractiveness and utility to which attention has been directed in the case of many previous volumes. The books should become popular guides for tourists, who will appreciate the interesting style in which they are written.

MODERN SUBSTITUTES FOR BUTTER.

Until the last few years the word margarine was usually associated, in the mind of the British public, with poverty; but now, under the new name of "Nuts and milk," with which advertising enterprise has made us familiar, it is becoming freely used in the kitchen, and is even found on the breakfast table in many households. On the continent, where the general standard of luxury is not so high as here, butter substitutes are used far more generally; and the demand for the raw materials from which they are made has increased to such an extent as to cause a noteworthy increase in their cost. In most cases the legislation affecting butter substitutes has been influenced by vested interests, so that, whilst only partially effective in preventing fraud, it has checked the development of the industry. Taking into account also the universal prejudice against margarine which prevailed formerly, it is very remarkable that the industry should have made such advances. It is of interest, therefore, to examine its development in some detail, more particularly from the scientific point of view; for it is desirable at the outset to emphasise that the margarine industry is essentially scientific in character, and that considerable technical skill is demanded in its manufacture.

The finished margarine must be satisfactory in taste, odour, and texture; this necessitates that the fats composing it shall be entirely free from fatty acids, and show no tendency to become rancid. Much depends on the texture of the fat, which the user expects to be the same as that of butter. The margarine maker so blends his raw materials that the mixture has the same melting point as butter, and he is able, further, to vary the melting point to suit the climate, an advantage which will be more fully appreciated in the future when margarine has found its way to tropical countries.

The present success of the margarine manufacturer is to a large extent due to the great variety of raw materials which are now available. In the early days of the industry soft beef fat was the sole basis obtainable; this was known as oleo oil or oleomargarine, and the conditions of its manufacture were not always above suspicion. This has now been entirely changed; the factories are models of cleanliness; they are officially inspected, and above all, animal fats have become of secondary importance to vegetable oils.

The process of manufacture is briefly as follows:—The carefully purified oils are blended at a suitable temperature, churned and pulverised with new or separated milk in suitable machines, cooled, washed, salted if required, and worked in exactly the same way as butter. The product is a butter substitute, and has the same composition, viz., about 84 per cent. of fat. Therefore on the accepted standards it has the same nutritive value.

A certain amount of butter fat is usually contained in the mixture, but by law this is not allowed to exceed 10 per cent. In Germany, Austria, and Denmark the presence of 10 per cent. of Sesame oil is obligatory for the purpose of earmarking the substitute. Sesame oil gives a colour reaction with certain reagents, which enables its presence to be very readily detected; for the British palate this addition of Sesame oil is unwelcome. In Belgium the addition of 0·2 per cent. of potato starch, as well as of 5 per cent. of Sesame oil to margarine is obligatory. It may be remarked that the analytical discrimination between butter and margarine is a lengthy process, and that the detection of 10 or 15 per cent. of added fat to butter is a matter of considerable difficulty. All fats are very much of the same composition, and with one or two exceptions they lack individual characteristics. The analyst depends, therefore, on small differences in physical characteristics, or on the proportion of fatty acids of low molecular weight, for their identification when in admixture.

It is an increasing practice in factories and for culinary operations in restaurants or in the kitchen to use the pure or blended fats themselves without churning them with milk. The advantages of this procedure are obvious, and it will be followed more generally by the housewife in the future. Thus in the United States, and in the poorer districts of our large towns, enormous quantities of refined cotton seed oil are sold for frying purposes, and the use of nut and blended butters containing 100 per cent. of fat for the same purpose is largely on the increase amongst the upper classes.

With the exception of olive oil the edible vegetable oils require very special refining before their characteristic flavours or impurities can be removed; in consequence it is only since these difficulties have been overcome in practice that they have been so largely used for margarine. It is certain that as the knowledge of refining processes increases, the development of the industry will be still greater. The methods of refining vary according to the oil; they are mostly jealously guarded as valuable secrets.

In Britain, and particularly in the United States, very large quantities of cotton seed oil are used either in margarine or for culinary purposes, both as a substitute for olive oil and as a cooking fat. About three-fourths of the world's production comes from the United States, about half of this oil being refined for edible purposes. The crude oil obtained by pressing the seed is first treated with caustic soda, then with fuller's earth, and finally made as nearly as possible free from taste and odour. From the point of view of the margarine maker, cotton seed oil is too liquid to be used in any large proportion, though its relatively low cost makes it a very desirable ingredient.

Far more important as butter substitutes are the nut oils—coco-nut, and palm kernel. The former is obtained by pressing copra—the flesh of the coco-nut, which is exported in a dried condition from its place of origin. In the past the copra-pressing industry has been localised at Marseilles, though in later years an almost equal quantity of material has been dealt with at Hamburg.

Palm kernels are the seeds of the palm fruit, of which the fleshy part is utilised for the manufacture of palm oil. The natives on the West Coast of Africa collect the kernels, crack and remove the shell before the nuts are exported to Europe. It is stated that kernels were first brought to Marseilles as ships' ballast and thrown into the sea on arrival until their value was recognised. Originally the chief receiving port was Marseilles, but latterly the industry has been almost entirely carried on at Hamburg, where in 1911 93 per cent. of the total quantity was dealt with, the remainder going to Liverpool.

The palm kernel oil made in North Europe last year is estimated at 125,000 tons, of which about 40,000 was refined for edible purposes. The kernels contain about 50 per cent. of oil, which is extracted by pressing in hydraulic presses similar to those used for copra. The residue, palm kernel cake or meal, has found a very wide use in Germany as an ingredient of compound cake for cattle feeding, and in this form has been largely exported to England. The commercial success of the pressing industry largely depends on the price obtained for this meal, and no pains have been spared on the Continent to demonstrate its value to the farmers by means of scientifically conducted feeding trials. There is at present much talk of developing the industry in Britain, in which case the disposal of the cake here will be an important consideration. It is of interest that the decline of the industry in Marseilles is largely due to the cake failing to find a ready sale as cattle food in the South of France. If the new industry is to succeed here it will have to be supported by the agricultural interests.

Some idea of the magnitude of the nut-oil industry is gained from the following figures:—The world's production of coco-nut and copra oil 1913-1914 is estimated at 377,000 tons, of which 300,000 tons were used in Europe. The total supply of hard vegetable fats (coco-nut and palm kernel oil) available for margarine is said to have been 240,000 tons in 1913, and perhaps 300,000 tons in 1914. Out of 347,000 tons of hard fat stated to be used for margarine in 1913, 204,000 tons were vegetable, and the quantity of vegetable fat used in 1914 may have amounted to 300,000 tons, *i.e.*, the total visible supply. There is little wonder that there has been a great increase in the price of these oils, and that the tropical sources of palm tree oils are being widely exploited. Nearly all tropical countries report an increase in the area under coco-nuts, or an improvement in the methods of dealing with the existing trees, and in the machinery for making copra or extracting the oil, which is still very primitive and inadequate.

The nut oils resemble butter and differ from all other fats in containing a large proportion of fatty acids of low molecular weight. Butter contains acids from butyric acid upwards in the homologous acetic acid series; the chief constituent of nut oils is lauric acid. Few of the remaining oils of commerce contain acids lower in the series than palmitic acid.

In preparing vegetable fats for the market the all-important consideration is the careful selection of the raw materials. The oil is worked as fresh as possible, so that the best results are obtained when the seed is pressed in this country. It should be understood that the refining process involves no treatment with chemicals except the agitation with weak alkali to remove the fatty acids present.

The importance of fats in the dietary requires no emphasis; on the other hand, it is questionable whether all fats have the same value as food materials. Fats, being glycerides, are decomposed in their passage through the alimentary system into glycerol and fatty acids. The decomposition is effected through the agency of an enzyme, lipase, so that the digestibility of the fat depends on the rate at which it is attacked by the enzyme. The fat has to be brought into a suitable state of emulsification before the enzyme can act on it; and though the factors controlling this state are still somewhat obscure, it is above all important that the fat should melt readily at the temperature of the body. Hence the comparative digestibility of a fat is in the first place based on its melting-point. Stearine is badly digested, liquid oleine is readily digested. The addition of sufficient oleine to stearine so as to reduce the melting-point of the mixture renders the stearine also digestible. Consequently the all-important point which margarine makers keep in view is the melting-point of their product in relation to the body temperature; if this is correct the material may contain some ingredients of a considerably higher melting-point.

It is of interest to note in this connection that vegetable fats are composed to a great extent of mixed tri-glycerides—that is, the glyceride contains more than one fatty acid in its molecule, whereas normally one molecule of glycerol is coupled with three molecules of the same fatty acid. Experience teaches that the melting-point of the fat will be greatest when these are all the same. The melting-point of the fat is further influenced by the fact that it consists of a number of different glycerides, both simple and mixed. Since mixing of fats has the result of altering the relative proportions of these it is evident that the final melting-point of a mixture cannot be predicted on theoretical grounds, and it is agreed that butter substitutes of suitable melting-point are as digestible as butter.

It is customary to measure approximately the nutritive function of a food by its energy value in calories per pound, but modern research has shown this method to be inaccurate in two respects. In the first place it ignores the quality of the food; secondly, it neglects the presence in traces of the vitamines.

It has been found by experimenting with isolated food substances that diets otherwise sufficient in energy value fail to maintain growth and health unless they contain certain substances hitherto unrecognised, but which have been named vitamines. The work in this field is of recent date, and is vitiated by the usual errors accompanying premature publication—indeed, much of it has been recalled already, but it would appear that the vitamines are of lipoid nature. They are present in butter, but not in the refined fats which are used for butter substitutes. How far this difference is of importance it is difficult to say; probably sufficient vitamines are present in the rest of the dietary to enable them to be dispensed with in the fat.

The question of quality is of more importance, though it has hitherto largely escaped attention. The individual fatty acids probably differ in their value in somewhat the same way as the different amino-acid constituents of the proteins have been shown to do, though to a less extent. The lower fatty acids in butter are perhaps specially important in making it of more value than olive oil, which is composed mainly of oleic acid, or than fats composed entirely of palmitic and stearic acids. Nut oils, however, resemble butter in containing a proportion of the lower acids, and hence their use in butter substitutes is entirely rational from the point of view of nutritive value.

In the foregoing the nature and preparation of materials available for use as butter substitutes have been indicated and their food value discussed. When it is remembered that the new industry is under rigid scientific control and conducted with a cleanliness mostly unknown in the butter industry, and, moreover, that it has made edible fats available for the masses at half the price of butter, it must be proclaimed as yet another of the achievements of science in the service of man.

THROUGH THE INTERIOR OF BRAZIL.[1]

IT is an instance of rare good fortune for a man who delights in the life of a field-naturalist to be offered the honorary leadership of a scientific expedition, by a Government not his own, through a large stretch of unexplored tropical country, to embark upon an unknown river, piecing it together with others but hazily known, and to have the now complete large river called after himself. However unique such a stroke of luck, the necessary premises are equally rare in their combination of an ardent naturalist, keen sportsman, vigorous experienced traveller, leader of men as a former president of the great American Republic, and attractive, versatile writer!

The idea of a journey through the interior of Brazil had been suggested to Colonel Roosevelt by Father Zahm, a missionary. It took shape when he was invited, through the Governments of Argentina and Brazil, to deliver addresses to their various learned societies, and he decided to combine this visit with a collecting tour for the American Museum of Natural History. When at Rio, the Government offered him the conjoint leadership of a scientific expedition which the Telegraph Commission was going to make through the very heart of the continent, down the now famous Rio Duvida. The geographical problem may be illustrated as follows. Let my right arm represent the lower Amazon river, the thumb the Tapajoz, the middle finger the Madeira, the index its most eastern and last tributary. The first joint of the index finger was known as the lower Aripuanan, composed of the upper Aripuanan and the Castanho river; this, the second joint, was known to rubber men only. The third joint represents the Duvida. A few miles of this river had been discovered by the Telegraph Commission in 1909, and there was a long gap between it and the Castanho of unknown extent. Moreover, it was not unlikely that the Duvida was, after all, but a tributary of the Gyparana, an affluent of the Madeira, already well known; and it was just possible that the river of Doubt turned sharp to the east and fell into the Tapajoz. However, the authorities ordered a party to ascend the Aripuanan up to the mouth of the Castanho and there to wait for the explorers.

The American party consisted of the Colonel and his son, Messrs. Miller and Cherrie as experienced zoological collectors, Fiala, of Arctic experience, as the handy man, and Father Zahm. Well found and equipped they left Asuncion on December 9, 1913, and ascended the Paraguay up to the headquarters of the Telegraph Commission, about 15° S. There is, extending towards north-west, the Serra Geral, the divide between the La Plata basin and that of the Amazon, but recently explored, with its numerous streams, by the Commission. Here the collections hitherto made were sent back, with Father Zahm. Fiala, with a few companions, was sent down a tributary of the Tapajoz. They got through, down this river, having lost everything but their lives. On February 3, 1914, the main party continued the journey with mule packs and ox carts, still following the telegraph and crossing many streams. Miller, with a small party, went on, to descend the Gyparana, etc., for Manaos, which turned out a most successful collecting trip. The main party combined with the Brazilian members: Colonel Rondon, chief of the Commission, Lieut. Lyra, and Dr. Oliveira.

FIG. 1.—One of the canoes. From "Through the Brazilian Wilderness."

They embarked upon the Duvida on February 27 in seven dug-outs, with sixteen paddlers, twenty-two men all told, with provisions for fifty days, hoping to reach the Madeira within six weeks. The starting point was at 12° 1′ S.; 60° 15′ W. All went well until March 3, when at 11° 44′ S. the first rapids were encountered. Then began the misery of portaging, carrying the loads and dragging the clumsy dug-outs through or past rapid after rapid, amidst dense forest, in the rainy season, with a plague of biting ants, flies, and termites which devoured their outfit. Nevertheless, the Colonel was "reading poetry in head-net and gauntlets." On one occasion it took them three full days to negotiate one mile of rapids. By March 25 they had descended only 160 kilometres of the winding river, had lost four canoes,

[1] "Through the Brazilian Wilderness." By Theodore Roosevelt. Pp. xiv+374. (London: John Murray, 1914.) Price 18s net.

including a new one made on the way, with provisions, ropes and pulleys, and one of the crew. A dog was killed by unseen Indians, the outfit had to be cut down to the utmost, and the sadly shrunk provisions had to be supplemented by palm-tops, fish, nuts, and an occasional monkey or wood-fowl. Illness, and a case of murder amongst the crew added to the depression.

Things were at their worst, when the river became more manageable, and when, on April 15, they came to the first house of rubber men, who informed them that they were on the Castanho river, about fifteen days from its confluence with the Aripuanan. This happened at 10° 24′. Henceforth, they enjoyed every help, and on April 26 they made the mouth of the Castanho, at 7° 34′, where Lieut. Lyra was encamped, waiting for the explorers. On the last of the month all the parties met at Manaos. By discovery and piecing together they had put on the map a new river; allowing for unknown headwaters and the windings of its whole, rather straight course, amounting to a total length of 1000 kilometres, not miles. This river enjoys now an abundance of names. Duvida + Castanho + Lower Aripuanan = Rio Roosevelt, as proclaimed officially by Colonel Rondon, but in one of the two maps of the book it is called Rio Teodoro. It was a very successful expedition, its object having been obtained in the way it had been planned.

Fig. 2.—Rapids of the Duvida From "Through the Brazilian Wilderness."

The various collections amounted to the great number of 3000 birds and mammals. Concerning the description of the country, its people, fauna, and flora, the narrative divides itself naturally into two parts. Soon after reaching the Duvida the pleasant occupation of collecting and observing had to give way to dangerous toil, the ways and means of getting through at all. Up to the divide Colonel Roosevelt had a glorious opportunity of indulging in the study of nature in her most varied aspects. He kept his eyes open, and, with a pleasant style, shows his delight whenever he comes across some creature he had not seen before. At the outset, at a visit to the serum-therapeutic institute at São Paulo, we get a lecture on snakes and their poison, and he assisted in experimenting with the mussurana, a snake-eating, harmless, immune snake. But we are not told its scientific name (*Rhachidelus brazili*, Blgr.) one of many similar regrettable instances in his book. The technical names are, of course, the bane of the vast majority of readers. Vernacular names are preferable, but there is a limit, and two words in brackets would satisfy everybody.

He speculates whether the white-tailed deer is an immigrant from the Northern Continent, arguing from the season of the shedding of its antlers. The marsh-deer, with its advertising red coloration, is just as successful as the black- and the white-tailed deer, which are found in the same neighbourhood. "Evidently it is of no survival consequence whether the running deer displays a white or a black flag." Pumas, ocelots, jaguars, spotted or quite black, were killed in the same locality. "In many cases coloration is of no consequence whatever; instead of being a survival factor, it becomes negligible through the other factors of overwhelming importance, as habits, cleverness, etc." Thus speaks the experienced sportsman on one of his favourite subjects. On another occasion he is puzzled why the jaguar should climb trees to escape dogs, "for ages have passed since there were in its habitat any natural foes from which it needed to seek safety in trees." Such and similar arguments usually do not come to much, but they are samples of scores that he did not go out merely to bag his jaguar. Birds, beasts, coral snakes, and piranha fishes, toads and ants, and primitive natives, he has something to say about, not always new, but to the point.

Every naturalist will agree with him that the mere collecting for museums is all very well, to a certain extent, a necessary evil, but what is now wanted are observations of the economy of the creatures, as parts of their environment. To secure such information, send out educated men who can give a readable account of their experiences. With exception of the two very sketchy maps most of the fifty illustrations are beautiful and characteristic.

H. G.

THE "ORIGINAL" SPECIFIC GRAVITY OF BEER.

THE December (1914) issue of the Journal of the Institute of Brewing is an important number of this publication, and of more than merely technical interest. It contains a series of reports and memoranda upon the subject of the determination of the "original" specific gravity of beer, and the results of the work described have now, by the Finance Act of 1914, been legalised as the basis for checking or determining the charge of duty upon this beverage. The main reports are contributed jointly by Sir Edward Thorpe and Dr. H. T. Brown, and the latter author supplements them by interesting studies of both the historical and the scientific aspect of the question.

Beer is taxed as being an alcoholic beverage, and it is popularly supposed to pay duty according to the amount of alcohol it contains. This, however, is not strictly the case. The basis of taxation is not the actual quantity of alcohol in the beer, but the specific gravity of the unfermented wort, which may be regarded as a measure of the quantity of alcohol potentially producible. Essentially, the wort of beer is a solution of various sugars—maltose, dextrose, cane sugar, and invert sugar—either arising from the malt and grain used, or directly added as such. The proportion of sugars varies considerably, according to the kind of product desired. In wort for producing strong ale, for instance, there may be twice as much sugar as in that destined for ordinary table beer. But, in the main, the proportion of sugar determines the specific gravity of the unfermented wort, and the specific gravity is therefore made the basis of the charge of duty levied on the beer. A brewer is thus left at liberty to ferment his wort as much or as little as he likes, and to produce a stronger or a weaker, a heavier or a lighter beverage, as his fancy dictates or his customers prefer.

As soon as fermentation commences, the specific gravity of the wort begins to alter, and in general to decrease. This is so for two reasons. First, the destruction of sugar by fermentation removes solid matter from solution; and secondly, the alcohol produced is specifically lighter than the wort. Hence, unless the specific gravity is determined before fermentation has commenced it is useless as the basis for the correct assessment of duty. It is impracticable, however, to have a revenue officer in attendance in all cases to take the specific gravity of the wort before fermentation begins; moreover, it often happens that the "collection" of the wort extends over several hours, during which time the first portions may have been in contact with yeast, and fermented to an appreciable degree, before the last portions have been added. Even were this not so, other difficulties arise. A large quantity of beer is exported, and the exporter is entitled to a "drawback" or rebate equivalent to the duty originally charged upon the unfermented wort from which the beer was made. Hence it is necessary to devise a method whereby the original specific gravity of the unfermented wort can be ascertained by the analysis either of the partly-fermented wort or of the finished beer, as the case may be.

As a first approximation, such a method may be based upon the well-known equations of Gay-Lussac denoting the conversion of sugar into alcohol. With maltose, for example, it is readily calculable from the equation:—

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O = 4\underset{\text{Alcohol}}{C_2H_6O} + 4CO_2,$$

that 100 parts of this sugar yield theoretically 53·8 parts of alcohol. Hence by determining the quantity of alcohol in a given specimen of wort or beer, we find the equivalent amount of sugar destroyed; and from the known density of solutions of maltose we can thus deduce the corresponding loss of specific gravity. Adding the number denoting this loss to the specific gravity of the residual wort or beer freed from alcohol, we can, theoretically, obtain the "original" specific gravity of the wort, *i.e.*, the gravity before fermentation had commenced.

In practice, however, this calculation is not sufficiently accurate. As Pasteur long ago showed in his studies of fermentation, a part of the sugar destroyed is not converted into alcohol. Moreover, different classes of sugars yield different percentages of alcohol. Again, the introduction of yeast complicates the matter, since part of the solid matter of the wort is used up in sustaining the growth of the yeast, and a sensible quantity of alcohol may be added as such with the yeast itself. These and other disturbing factors, small individually, together affect the result sufficiently to render the figures given by the simple theoretical method, as outlined above, only an approximation to what obtains in actual brewery operations.

We have, in fact, to fall back upon an empirical basis for the calculation of results sufficiently accurate to be used in practice. Starting with worts of known specific gravity, fermentations may be carried out, and from the examination of samples drawn as the process continues, it can be ascertained experimentally what is the actual loss of specific gravity consequent upon the production of known quantities of alcohol. Such experiments, in fact, have been made, and the results have been embodied in statutory tables for use in assessing the duty on beer.

Manifestly it is of much importance that these tables should be true and just. If inaccurate in one direction they are unfair to the public by reason of the loss of revenue entailed; if erroneous in the opposite sense they are unfair to the brewer.

The first original gravity tables were constructed in the year 1847 by Messrs. Dobson and Phillips, of the Inland Revenue Department. They were drawn up with considerable care; but some discussion having arisen, the whole matter was referred a few years later to Profs. Graham, Hofmann, and Redwood, whose report was presented to the authorities in 1852, and published the same year in the Journal of the Chemical Society. For some time past it has been known that the table supplied with this report is less accurate than is desirable—not, it appears, from any inherent errors, but from having been based upon fermentations which differed in some respects from those obtaining in ordinary brewery practice. About six years ago, therefore, the Commissioners of Customs and Excise gave instructions for a revision of the table to be made. This was undertaken by Sir Edward Thorpe, who was at that time principal chemist of the Government Laboratory, conjointly with Dr. H. T. Brown, nominated on behalf of the brewing trade by the Council of the Institute of Brewing. The necessary experiments, which altogether extended over a period of about two years, comprised not only brewings made under laboratory conditions, but an extensive series of observations at representative breweries, in order to obtain data which should correspond fairly with the actual working conditions met with in modern brewing practice. In the result a table has been constructed which there is every reason to believe is trustworthy, and which has now been legally established for use in place of the former statutory table of Profs. Graham, Hofmann, and Redwood. As compared with the older table, its general effect is somewhat to increase the amount of duty chargeable.

Dr. Brown's special contribution is a valuable study of the scientific principles underlying the empirical method of determining original specific gravity. He shows that a reasoned or "theoretical" process is quite possible—though not necessarily preferable—if the data have been properly established. C. Simmonds.

ROLL-CALL OF BRITISH BIRDS.[1]

We have received from the British Ornithologists' Union the second and revised edition of its "List of British Birds." It is an authoritative compilation which does credit to the zeal and carefulness of the editorial committee. While the task was only accomplished by division of labour, the whole has been revised by the entire committee, who consider themselves jointly responsible, although many disputed points have been decided by the votes of the majority. The first edition, published in 1883, included 376 birds; the present edition has 475, quite apart from a long list of species the presence of which has been recorded, but not satisfactorily proved.

It is interesting to look into the composition of the list of 475 birds. In the first place, 188 are regular breeding birds, and 286 are non-breeding, and one (the great auk) is extinct. The list may be further sub-divided. Thus, there are 141 residents, including, of course, many that are partially migratory. In this category are included three introduced birds—the little owl, the pheasant, and the red-legged partridge, besides the capercaillie, which was indigenous, but became extinct about 1760–70, and was re-introduced from Sweden in 1837–8. A second set is made up of 47 summer visitors, including a few which occasionally leave representatives with us in winter. The third set consists of 46 winter visitors; the fourth of 30 birds of passage; the fifth of 61 occasional visitors which have occurred on more than twenty occasions.

The largest category in the classification is that of rare visitors, which have been recorded on fewer than twenty occasions. This group numbers 149, which shows how diligent the search for the occurrence of rare birds has been in the British Islands. Under each bird we find a few references, the etymology of the name, the distribution in the British Islands, and the general distribution. A long appendix is devoted to the birds which have been excluded because the evidence of their occurrence is not regarded by the committee as entirely satisfactory. Two others deal with questions of nomenclature. The members of the committee deserve the thanks of all ornithologists for the effectiveness with which they have done their work, which must have made heavy demands on their time and afforded abundant exercise for their judgment.

[1] "A List of British Birds." Compiled by a Committee of the British Ornithologists' Union. Second and Revised Edition. Pp. xxii+430. (London: W. Wesley and Son, 1915.) Price 7s. 6d.

NOTES.

We learn with much regret of the sudden death on March 23, through heart-failure, of Prof. Otto N. Witt, professor of chemical technology in the Technical High School at Charlottenburg.

Dr. F. Taylor, consulting physician to Guy's Hospital, has been elected president of the Royal College of Physicians in succession to Sir Thomas Barlow.

The fifth annual award of the Willard Gibbs Medal, founded by Mr. W. A. Converse, of Chicago, has been made, says *Science*, to Prof. A. A. Noyes, director of the research laboratory of physical chemistry, Massachusetts Institute of Technology.

A strong after-shock of the Avezzano earthquake of January 13 was felt in Rome on April 5, at 7.20 a.m. (6.20 G.M.T.). According to a report issued by the geodynamic observatory at Rome, the epicentre of the after-shock appears to have been close to Avezzano.

The American Philosophical Society will meet at Philadelphia on April 22–24 for the reading and discussion of papers. The programme includes papers on many subjects of recent research in physical and natural science, and also a symposium on the earth: its figure, dimensions, and the constitution of its interior.

Dr. J. Scott Keltie, who has been secretary of the Royal Geographical Society since 1892, vacated that office at the end of last month, and has been succeeded by Mr. A. R. Hinks, who has been assistant secretary of the society since 1913. Dr. Keltie will not, however, entirely sever his official connection with the society, for he has undertaken to act with Mr. Hinks as joint-editor of the *Geographical Journal* for the next two years.

It is announced in the issue of *Science* for March 12 that Col. George W. Goethals has been promoted to be a major-general of the line in recognition of his services in the construction of the Panama Canal. Brig.-Gen. William C. Gorgas, surgeon-general, has been promoted to be major-general in the medical department. Col. H. F. Hodges and Lieut.-Col. W. L. Sibert, U.S. Corps of Engineers, have been promoted to be brigadier-generals. The Bill authorising these promotions extends the thanks of Congress to the officers mentioned.

We regret to see the announcement of the death on Sunday, April 4, at fifty-eight years of age, of Dr. H. Lewis Jones, medical officer in charge of the electrical department at St. Bartholomew's Hospital, and a leading authority upon electro-therapeutics. Dr. Jones was president in 1903–4 of the British Electro-Therapeutic Society, and acted as official delegate for the British Government to the International Congress of Physiotherapy at Liège in 1905, and also at Paris in 1910. He was the author of "Medical Electricity," and of numerous papers on the principles of ionic medication and related subjects.

The desirability of excluding cotton from Germany and Austria has been urged upon the Government by a number of men of science. At a conference on March 10 a letter was drawn up and sent to Lord Moulton at the High Explosives Department of the War Office, pointing out that Germany is entirely dependent on her imports of unspun cotton for the manufacture of propulsive explosives, and asking whether a complete embargo on cotton destined to Germany and Austria by any channel had been declared and would be exercised. Among the signatories to the letter were Sir William Ramsay, Prof. Clowes, Sir Alex. R. Binnie, Prof. H. Jackson, Mr. B. Blount, Prof. Meldola, and Prof. W. J. Pope. Lord Moulton replied on March 19 to the effect that the Order in Council of March 11 would, he thought, satisfy the signatories, who, however, on March 22 pointed out that the Order in Council would become effective only if cotton were made contraband of war. Further correspondence has taken place, and the signatories have had an interview with the Board of Trade, but they appear to have been unable to obtain the assurance they desire for the prevention of the importation of cotton by Germany.

The present shortage in this country of synthetic yellow dyes has put difficulties in the way of manufacturers of khaki cloth. A temporary way out of the difficulty was found, however, by the increased use of fustic, a natural yellow dye-stuff, consisting of the wood of a tree (*Chlorophora tinctoria*) which grows freely in Jamaica and also in British Honduras. When the shortage of yellow dye-stuffs first became apparent the Imperial Institute took steps to place British dye firms in touch with exporters of fustic in Jamaica. Only a moderate amount of cut fustic wood was, as it happened, then available in the island, but, as a result of the institute's action the Government of Jamaica has offered to purchase from the growers further supplies, and carry these at Government cost to Kingston, the port of shipment. Negotiations are accordingly now pending for the purchase and shipment of considerable quantities of Jamaica fustic by dyers in this country. The Government of British Honduras is also taking action in this matter, and a further supply of the wood may possibly be forthcoming from that Colony. Further information may be obtained on application to the Imperial Institute, South Kensington, London, S.W.

By the death of Mr. J. J. Beringer on March 28, Cornwall has lost an indefatigable worker whose investigations in the science of mining and metallurgy made him one of her most prominent and interesting personalities. A personal friend, W. H. T.-J., sends us the following particulars of his career and work. Born at Penzance, Cornwall, in 1857, Mr. Beringer was educated at Redruth. In 1877 he won a Royal Exhibition, and took the course of the Royal School of Mines in London. In 1880 he passed his examinations with distinction, and secured his diploma A.R.S.M. In 1881 he became assistant in the chemistry and assaying department to Prof. Huntingdon at King's College, where his work was very highly appreciated. From 1882 to 1891 he was lecturer to the Miners' Association, also public analyst for the county of Cornwall. From 1882 down to the date of his death, he was principal of the County School of Metalliferous Mining, Camborne, of which he also was made a governor, and it is mainly in that position that he distinguished himself as a lecturer of remarkable ability on mining and metallurgical subjects, not only by his erudition, but also by his sympathetic hold on his students. He was the author of a text-book on assaying, which has gone through some ten or more editions, and remains to-day the standard text-book in Great Britain, and may be said to be used in nearly all schools of mines throughout the world. The Institution of Mining and Metallurgy, in recognition of the distinguished services he had rendered to the science and industry of metallurgy, bestowed upon him the honorary membership of the institution. His death was partly due to weakness induced by severe and continuous overwork, and especially by the loss of vision in one eye due to his close application to microscopic and ultra-microscopic work. His loss will long be keenly felt, especially in Cornwall, by a large circle of personal friends, including the many students who passed through his hands.

In the University of Pennsylvania's Anthropological Publications, vol. iv., No. 2, Mr. M. R. Harrington describes a remarkable collection of the sacred bundles of the Sac and Fox Indians collected by the expedition maintained by Mr. G. G. Heye. These bundles, containing many heterogeneous articles, are held in the highest veneration, and in many cases the religious observances of the tribe centre round them. The concepts underlying their use are often obscure, but the idea at the basis is that they are endowed with some supernatural power or *mana,* which directly influences the phenomena of life in the interest of their owner. The bundles are supposed to possess a consciousness of their own, to understand what is said to them, and to enjoy offerings presented to them. Some are used in religion, some in war, while others are of a private nature, and bring success in hunting or in love, heal the sick, promote health, bring luck in sports, gambling, or are used in witchcraft. Some belong to shamans, others are in private hands. A full catalogue with photographs fully illustrates this interesting collection.

IT is generally held that the presence of *B. coli* in pasteurised milk indicates either that the milk has not been properly heated, or that it has been subsequently reinfected by careless handling. In the *Journal of Agricultural Research* for February, S. H. Ayres and W. T. Johnson, jr., describe experiments which suggest that this conclusion may not always be justified. From an examination of pasteurised milk supplied by twenty-four dairies in Amsterdam, Ringeling declared that nearly half of them did not pasteurise or handle the milk properly, since he found *B. coli* in the samples received from ten of the dairies. In recent years many investigators have found that cultures of *B. coli* were easily destroyed at temperatures below 60° C., which is the lowest pasteurising temperature, but certain strains required heating for 30 mins. at 70° in order to destroy them. The authors have studied the thermal death-point of 174 cultures of typical colon bacilli, isolated chiefly from cow fæces, as well as from milk, cream, flies, human fæces, and cheese. These cultures were heated in milk at temperatures ranging from 52° C. to 68° C. for 30 mins. At 63° C., the usual temperature of pasteurisation, 6·9 per cent. of the cultures survived, but only one culture (0·6 per cent.) survived heating to 66° C. Repeated heatings of the cultures that survived the normal pasteurising process showed that 63° C. is a critical temperature for the comparatively few resistant strains, which are able to survive the original heating by the resistance of a few organisms only. If milk is pasteurised at 66° C. or above for 30 mins., the authors expect from their results that no colon bacillus would survive. Consequently under such conditions the *B. coli* test for the efficiency of pasteurisation may be of value. It is, however, possible that a study of a larger number of cultures would show that some strains may survive even higher temperatures.

VOL. xi., part 1, of Records of the Indian Museum contains articles on boring-sponges of the family Clionidæ, by Dr. N. Annandale, on hermit-crabs from the Chilka Lake, by Mr. J. R. Henderson, and on some South Indian frogs, by Mr. C. R. N. Rao, as well as two others. Of five species of hermit-crabs only one is described as new.

THE beauty and delicacy of execution of the two plates (reproduced from photographs) form a striking feature of a memoir by Mr. S. Yehara on Cretaceous trigonias from Miyako and Hokkaido, published as vol. ii., No. 2, of Science Reports of Tohoku Imperial University, Sendai, Japan, series 2 (Geology). The beautiful preservation of the specimens themselves is likewise noteworthy.

IN the *American Naturalist* for March Mr. R. R. Hyde describes a fly of the species *Drosophila confusa*, reared by himself, which differed from the normal form by the curvature of the wings. In the new form the wings curve upwards at an angle of about 45° from the end of the abdomen, and thus somewhat resemble rose-petals, instead of projecting horizontally over and above the abdomen, as in the wild form. Unfortunately, all the members of the new stock died during the hot weather of the summer of 1914.

THE problem of utilising museum collections for the use of children seems to have been satisfactorily solved by the authorities of the Museums of the Brooklyn Institute of Arts and Sciences, whose report for 1913, unusually belated, has just reached us. The museum for children has been brought into close relation with the city schools, the majority of visitors being under fourteen years of age. Well-arranged series are adapted for purposes of instruction, and the library serves the threefold purpose of supplying children with books and magazines relating to their studies, their clubs, and their hobbies. The total attendance was nearly 48,000, and about 2300 parents and other adults attended, some with their children, others desiring help in choosing children's books, while others who began coming in their early days continue their visits. Teachers are encouraged to inspect the collections under the guidance of experienced instructors. The scheme seems to be well organised, and an examination of it may be useful to school authorities in this country.

THE uncertainty that prevails with regard to the correct zoological names of many of the commonest or most familiar animals is a source of great confusion, especially to those who make use of such names without being themselves experts in the study of the particular class of animals dealt with. It is, for instance, extraordinarily perplexing for a medical practitioner or student to see common human parasites appearing under different names in different books, or the same name applied to quite distinct species by different authorities. The efforts, therefore, that are being made by the International Commission on Zoological Nomenclature to fix the names of animals in cases where the matter is in dispute, will be welcomed by all who require to make use of the names. The latest "Opinion" (No. 66) issued by the Commission deals with certain genera of Nematodes and Gordiacea, including the round-worms parasitic in man, namely, *Ancylostoma* (type *duodenale*), *Ascaris* (type *lumbricoides*), *Dracunculus* (type *medinensis*), *Gnathostoma* (type *spinigerum*), *Necator* (type *americanus*), *Strongyloides* (type *intestinalis = stercoralis*), *Trichostrongylus* (type *retortaeformis*), *Gordius* (type *aquaticus*), and *Paragordius* (type *varius*). The first of these genera, of which the type is the "Old World Hook-worm," notorious as the cause of miner's anæmia, has hitherto appeared under about a dozen different spellings, including even such barbarous forms as "Agchylostoma"; it is to be hoped that in the future uniformity in this respect will be maintained.

IN Records of the Botanical Survey of India, vol. vi., No. 5, an account is given by Mr. M. S. Ramaswami of a botanical tour in the Tinnevelley Hills.

A good map is included showing the author's route. Of the 470 species collected, thirty-three, or about 7 per cent. of the whole, are endemic to the region, 2 per cent. are purely Ceylon species, and 10 per cent. are peculiar to the South Indian peninsula. Leguminosæ, with fifty-five species, and Rubiaceæ, with thirty-eight, are the most extensively represented natural orders. One new species, *Senecio calcadensis*—a composite—is described and figured.

The Missouri Botanical Garden completes its first volume with several interesting papers. Mr. E. A. Burt contributes a third paper on the Thelephoraceæ of North America, and details twenty-one species of Cyphella. Mr. R. R. Gates publishes an account on some Œnotheras from Cheshire and Lancashire, with three well-executed plates. The work represents the results of cultivation and hybridisation both at the Missouri Botanical Garden and the John Innes Institution at Merton, and details of the new forms, both mutants and hybrids, are given. In the same part Messrs. Greenman and Thompson describe and illustrate new species of flowering plants from the south-western United States and Mexico.

The first number of the *Kew Bulletin* for 1915 is mainly occupied by a paper on the semi-parasitic genus Thesium in South Africa, which is illustrated by two plates showing the different types of floral morphology. The genus which exhibits its maximum development in South Africa has been studied in connection with the preparation of the "Flora Capensis." Some 128 species are found to be represented at the Cape, belonging to four well-marked floral types or sections. Two of these, the sections Penicillata, in which the tuft of hairs behind the anther remains free and not attached to the anther, and Annulata, where a ring of hairs at the throat of the perianth replaces the tufts of hairs behind the anthers, are peculiar to the Cape region. A fresh description of the genus is given, a key to all the South African species, and fifty-two diagnoses of new species are published by Mr. A. W. Hill. The distribution of the genus is remarkable. The majority of species are African, but several are spread over Europe and temperate Asia, while two occur in Brazil and one in Australia.

The permanence of the aroma of hops of a particular variety when grown in another locality has long been a vexed question. Mr. Johs. Schmidt has been carrying out investigations at Carlsberg, and has satisfactorily proved that if pure lines of hops with the "Saaz" aroma from Bohemia, or Oregon cluster hops, with the distinctive and peculiar "American" aroma, are grown in Denmark, they do not lose their characteristic qualities. The experiment of cross-fertilising these varieties with pollen of wild Danish hops has also been made, and it was found that a proportion of $\frac{3}{4}$–$\frac{1}{2}$ the offspring exhibited the characteristic aromas of the female parents, though the plants carrying the aroma did not necessarily retain the external appearance peculiar to the mother plant. These latter results are similar to those recently published by Mr. E. S. Salmon from crossing female Oregon cluster by English male plants. The series of experiments suggest an interesting line of Mendelian research. Mr. Schmidt's paper appears in *Comptes rendus des travaux du Laboratoire de Carlsberg* (11me volume, 3me livraison, 1915).

Prof. A. P. Brigham's presidential address to the Association of American Geographers, delivered at the meeting in Chicago at the end of last year, is published in *Science* of February 19. Broadly speaking, his theme was that the geographer's "goal is broad generalisation. But the formulation of general laws is difficult and the results insecure until we have a body of concrete and detailed observations." Prof. Brigham's geographical keynote is environment, and certainly in this study the generalisations which have hitherto preceded detailed observations have presented many pitfalls. Prof. Brigham's address was full of suggestions for detailed research in various fields. In an early paragraph he referred to the symposium on the trend of modern geography conducted by G. B. Roorbach, and published in the Bulletin of the American Geographical Society for November, 1914. This marshalling of the views of some thirty geographers, mainly American, but some British, pointed to the same conclusion. It perhaps gave unfair weight to a particular aspect of geographical opinion, inasmuch as fully two-thirds of those whose views were given were professors or other teachers, and the mathematical and cartographical department of the subject received rather scanty treatment. This apart, however, most of them expressed their ideas of the functions of geography in a variety of carefully worded formulæ all of much the same meaning. In indicating fields of research, they were less successful than Prof. Brigham, and some suggestions (in the direction of climatology, for instance) travelled well outside the geographical scope.

Dr. Bruce and Dr. Rudmose Brown gave an account to the Royal Geographical Society on March 22 of Dr. Bruce's expedition to Spitsbergen in 1914. Its object was to investigate Stor Fiord, the great bay to the south-east of Spitsbergen. Difficulties due to the war seriously interfered with their plans, and most of the time was spent in geological work on Prince Charles Foreland, the island off the western coast of Spitsbergen. Most of the paper was devoted to a discussion of the ownership of Spitsbergen. The authors of the papers claimed that the archipelago should be British in virtue of prior claim. After the abandonment of the whaling fishery, the country was long left derelict, but during the last forty years claims for its possession have been advanced by Russia, Norway, and Sweden. In 1909 the United States suggested the establishment of an American protectorate. In 1912 a conference between Norway, Sweden, and Russia agreed that Spitsbergen should remain neutral territory and be jointly administered by those three Powers. Drs. Bruce and Brown maintain that this agreement would deprive Britain of any voice in the future of Spitsbergen, despite her right of ownership due to annexation, exploration, and preponderating commercial interests They represent this agreement as a practical surrender of Spitsbergen to Russia, which they insist has practically no claim to the country. In the development of the coal-mining the American interests are important though localised, and are of less value than the British. The authors urge that in consequence of the growing commercial development of Spitsbergen some definite government must be established, and they claim that many of those interested in the country consider its interests would be best served by the establishment of a British protectorate.

A Society of Vulcanology has recently been founded in connection with the University of Catania. The objects of the society are to collect accounts and photographs of the volcanic phenomena of Etna and Sicily and specimens of the materials ejected, and to encourage generally the study of vulcanology. We have received the first four numbers of the *Pubblicazioni* issued by the society. They include papers by Prof. G. Platania on the recent eruptions of Etna and on a proposal for the international organisation for the study of volcanoes.

The well-known Vesuvian Observatory was built in 1841. Its first director, the physicist Melloni, was removed shortly after taking office, on account of his action in political movements. The observatory then remained closed until 1852, when Palmieri obtained permission to make use of it for his own investigations. Four years later he was appointed director by the Neapolitan Government, though regular observations only became possible when he was provided with an assistant at the close of 1863. Four of the six papers which appear in the last five numbers of the *Bollettino* of the Italian Seismological Society relate to Vesuvian phenomena and to work done in the observatory since the latter date (vol. xviii., pp. 87–338). Mr. A. Malladra studies the rainfall of Vesuvius during the fifty years 1863–1913, and the effects of volcanic gases on vegetation. He also describes the seismographs and seismoscopes in the observatory and various chambers in the neighbourhood. Some of these are of modern Italian construction and are capable of recording strong earthquakes in all parts of the world. An important paper is that by Mr. C. Cappello on the variations in the altitude of Vesuvius from 1631 to 1906, and in the outline of the mountain in the years 1911 to 1914. After the eruption of 1906, the greatest height of the crater rim was 4013 ft. on the west-south-west side, the least 3619 ft. on the opposite side, and the greatest diameter of the crater about 2395 ft.

A plot of ground covering seventy-five acres, which includes the remarkable Green Lake near Jamesville, N.Y., with its series of abandoned cataracts, rock channels, and dry plunge-basins, has been given to the New York State Museum by Mrs. Mary Clark Thompson, of New York, and presented in the name of her father, Myron H. Clark, a former governor of that State, and by her desire it is to be known as the "Clark Reservation." The significance of the conformation of the new reservation has, says Dr. J. M. Clarke, in *Science*, been worked out by Prof. Fairchild and Mr. E. C. Quereau. In the course of Prof. Fairchild's work upon the Pleistocene geology of New York State, he demonstrated the accuracy of Mr. Quereau's suggestion that in the retreat of the ice mantle the outflow of the glacial waters was by way of great rivers moving eastward into the Mohawk-Hudson drainage, and in the Green Lake one of these streams cut its rock gorge in the limestones of the Helderberg escarpment and left a series of plunge-basins beneath great cataracts which surpassed the dimensions, as they must have equalled the dignity and grandeur, of Niagara. The lake is surrounded on all but its eastern side by an amphitheatre of sheer limestone cliffs rising to a height of nearly 200 ft., and the depth of the lake is stated to be not less than 100 ft. Water of a deep emerald hue still fills this ancient plunge-basin, without visible outlet or inlet.

A valuable investigation of the "Absorption, Reflection, and Dispersion Constants of Quartz" has been carried out by Mr. W. W. Coblentz, and published as Bulletin No. 237 of the Washington Bureau of Standards. Unlike fluorite, quartz shows a marked absorption in the infra-red at 2μ, and becomes practically opaque beyond 3μ; but from $0{\cdot}25\mu$ in the ultra-violet to $1{\cdot}7\mu$ in the infra-red it is almost perfectly transparent in thicknesses up to 3 cm. Thus, after allowing for losses by reflection at the interface between quartz and air, the transmission is actually found to be 100 per cent., if an allowance of 2 parts per 1000 is made for experimental error. The absorption does not appear to be affected by the direction in which the radiations pass relatively to the optic axis of the quartz.

In the Annals of the Association of American Geographers, vol. iv., Prof. de Courcy Ward gives an excellent account of the general features of American weather regarded from the point of view of climate. Although climate is usually defined as the average of weather, the irregularities of weather, the variations from day to day, are in some respects more significant than averages: in addition to averages, we require frequencies and rates of change to get even an approximately true representation of climate. Prof. Ward shows how in winter the controlling factor in America is the non-periodic variation arising from the passage of cyclones and anti-cyclones: the storm control, he calls it expressively. In summer, on the other hand, the non-periodic variations are less dominant than the regular diurnal changes: storm-control is subordinate to solar-control. The paper is illustrated by diagrams showing the different paths of cyclones and anticyclones and the changes in the weather as the cyclones and anticyclones cross the country. The distribution about the cyclonic centres is illustrated for different seasons, and the changes which take place at a fixed spot as the cyclones pass over it are shown by reproducing curves from self-recording instruments.

The February number of the Journal of the Royal Microscopical Society contains a paper which Mr. J. E. Barnard read before the society in December last on the possibility of utilising Röntgen rays in microscopic work. In his experiments the author has used the soft rays from a tube provided with a lithium glass window. The rays can only pass out of the lead chamber in which the tube is enclosed through a series of fine holes in lead screens in line with each other, and in consequence they strike the photographic plate as a parallel beam. The object to be photographed is placed in contact with the plate, which is enclosed in a light tight box. Plates with thin gelatine films and very fine grain must be used. The time of exposure depends on the thickness and opacity of the object, and the author prefers to use the harder rays from the tube as the opacity increases. The resulting photographs are the same size as the object, and must be enlarged by the usual photographic method. Six reproductions of photographs showing the internal structure of microscopic objects are given in the paper.

The *Rendiconti* of the Italian Chemical Society (vol. vii., pp. 173–222) has an interesting discussion of the relationship existing between Mendel's principles of heredity and the atomic theory by Prof. C. Vulpiani. A brief survey is given of the recent developments of our views as to the atomic and molecular state, and an attempt is made to show that the natural basis of the hereditary elements which are transmitted according to Mendelian laws is to be found in the molecular or atomic groupings present within the cells, and of which the chromosomes are only the outward visible manifestation. The author very justly emphasises how the Mendelian laws of heredity have led to a more general recognition of the complexity of cell protoplasm. The view that each hereditary element corresponds with some material factor in the ultramicroscopic or molecular structure of the contents of the reproductive cells will undoubtedly lead to more correct conceptions being formed as to the nature of cell protoplasm than those which have in the past been current among biologists.

A paper on the processes of manufacture of wrought iron and steel tubes was read by Mr. J. G. Stewart at the Institution of Engineers and Shipbuilders in Scotland on February 16. The author states that it is very rarely that potable waters are found to have any appreciable corrosive effect on steel pipes, and quotes several instances of pipes which have been in service many years with very little deterioration. The principal fear is for the outside of the pipes. Most natural ground, especially clay, is not only innocuous, but is actually a permanent protection to steel pipes from corrosion. In some cases where the pipes are laid through artificially made, or alluvial ground, external protection is desirable. The want has been met by dipping the pipes in a hot bath of Dr. Angus Smith's or other bituminous solution, and in cases where the ground contains an excessive amount of salts and acids which cause corrosion, the additional precaution is taken of wrapping the pipes in coarse jute Hessian cloth saturated with the hot solution, winding it spirally on the already coated pipe.

The March number of the Journal of the Franklin Institute contains a paper on paints to prevent electrolysis in concrete structures, by Mr. H. A. Gardner, assistant director of the Washington Institute of Industrial Research. An extensive series of experiments on iron rods of 1/2 or 3/4 in. diameter embedded in concrete cylinders 1 ft. long has been carried out by the author to determine what type of paint was most effective. The rods were thoroughly cleaned, and two coats of the paint applied, each being allowed a week to dry. They were then embedded in the concrete, which was aged for a month before the test was commenced. Each cylinder was then immersed in water, and a potential difference of 30 to 100 volts applied for 10 days between two rods in each cylinder, or between one rod and an outside electrode, the current transmitted being observed. In all cases in which an appreciable current passed, the concrete cracked round the anode. The uncracked cylinders were tested for the strength of the bonding between the iron and the concrete. The author concludes that the paint should be prepared from boiled or bodied oils which dry by polymerisation rather than oxidation, that the pigments should be insulators and should give a rough surface, and that the paint should have fine sand scattered over it before it is quite dry.

We are asked by the proprietors of the Mallock-Armstrong ear defender described in last week's Nature (p. 131) to say that since January 1 of this year all the defenders sold have been of an improved pattern, furnished with gold-plated gauze wire to resist corrosive effects—such as those of sea air—and generally are more expensive to make than those first put on the market. Accordingly the price is now 4*s.* the pair, instead of 3*s.*, as stated in our notice.

OUR ASTRONOMICAL COLUMN.

Comet 1915*a* (Mellish).—The following is a continuation of the ephemeris given last week:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
April 10	18 14 8	−3 6·8	8·1
12	16 21	3 32·3	
14	18 32	3 59·7	8·0
16	20 42	4 29·3	
18	18 22 51	−5 1·3	7·8

The comet is situated a little to the east of η Serpentis.

Measures of Saturn.—From December, 1913, to March, 1914, Prof. Percival Lowell made a series of measures of the ball, rings, and satellites of Saturn with the 24-in. of the Lowell Observatory. They were taken, as he states, "with an eye to the irradiation," and the measures have been deduced to what is commonly taken as the mean distance. These are now presented by the author in a communication to the Lowell Observatory Bulletin No. 66 (vol. ii., No. 16). The diameter of the ball as determined from direct measures, measures of satellites, and measures of B ring is first given, followed by measures of the radius of the ball, breadths of B and A rings, and width of Cassini's division. All these are summed up in a table giving the means of the measures for mean distance, followed by a table of the direct measures of the diameter of Titan.

Stars with Variable Radial Velocities.—Several communications are contained in No. 267 of the Lick Observatory Bulletin. The first, by Mr. R. E. Wilson, gives the details of fourteen stars which have recently been found to have variable radial velocities, from plates taken by the D. O. Mills expedition to the southern hemisphere. The same author deduces the orbit of the spectroscopic binary ν Centauri, giving the period as 137·939 days. This star is one of a group of Class B binaries, which have periods of about 130 days. Mr. R. F. Sanford describes his investigation of the orbit of the spectroscopic binary ϵ Volantis, a star of magnitude 4·5 and of Class B5. The new elements show a period of 14·16833 days. A note by the same author on two spectrograms of the interesting irregular variable η Carinæ indicates that the observations of 1913 and 1914 show no evidence of variation in radial velocity.

SOLAR RADIATION MEASURES IN EGYPT.—Bulletin No. 14 of the Helwân Observatory contains an account of some observations of solar radiation which have been carried out at the Helwân Observatory by Mr. Eckersley. It has been shown by Prof. Abbot that values of the "solar constant" vary from day to day, and that even at two stations as far apart as Mount Wilson (California) and Bassour (Algeria) there is a very well-marked correspondence between the values derived at these stations, so that the action of local atmospheric effects is not the cause of the fluctuations. Prof. Abbot considers the outstanding variation to be due to a real fluctuation of the solar constant. In order to investigate this question further, it was decided to make an extended series of observations at Helwân, and this was commenced at the beginning of last year. The account of these measures is given in this paper. For the statistical purpose of comparing the results obtained with those at Mount Wilson, the highest precision of individual observations is not required, but an extended series of measurements uniformly treated is of the greatest value. For this reason pyrheliometer measures of the total energy alone were made. The communication describes the method employed, the reduction of observations, and the results secured. While the value of the radiation derived from the Smithsonian Institution observations at Mount Wilson is 1·932 (mean value of 696 observations taken at Washington, Mount Wilson, and Bassour during the period 1902–1912), the Helwân mean value derived is 1·782. The latter value is considerably less than the Smithsonian mean value, and the cause of the difference is dealt with by the author in subsequent paragraphs. Finally, evidence for the fluctuation during the period of observation is dealt with, and it is concluded that while some of the deviations are probably due to real fluctuation, no conclusive decision can be reached until the Mount Wilson results can be compared.

THE BRILLIANT FIREBALL OF SUNDAY, MARCH 28.

BETWEEN March 21 and 29 eight large meteors were observed, but by far the most brilliant object among them was that of March 28, 7.47½ p.m. Its flight was witnessed by many hundreds of persons from the southern parts of England, as well as from the English Channel, France, and Belgium.

As viewed from London, the meteor sailed slowly along a few degrees under the stars Sirius and Rigel, and further westwards to possibly beyond γ Eridani. Mr. H. P. Hollis saw the meteor from a place about three miles due east of the Royal Observatory, and estimated its duration of flight as between five and six seconds. He did not see the beginning, and it was difficult to trace the exact point of extinction owing to trees behind which the object passed.

Mr. G. P. B. Hallowes was in his observatory at East Howes, Bournemouth, with an astronomical friend, Mr. C. Gregory, when the meteor burst out in the southern sky. It moved from the region of α Hydræ to near Rigel at about the place of ν Leporis. It passed a little above Sirius. Brilliancy far exceeded Venus, and its duration was from three to four seconds. A trail 5° or 6° long followed the nucleus, and the latter burst into fragments at the end. The front of the head was yellow, the rear part red. Diameter, about 15′, or half that of the moon.

Mr. A. King saw the meteor from Scunthrope, Lincolnshire, and from this northerly position its apparent path was very low, being from about $117° - 31°$ to $98° - 32°$. The brightness was estimated equal to Sirius, the colour yellow-green, and duration 7½ seconds.

Mr. H. Rollason, of Montgomery, Wales, states that the meteor flamed out on the western sky, moving from S.E. to N.W., bursting twice, and enduring altogether five to six seconds. Many other observations have been received or published in the daily papers. As usual, there are discordances, but it is not difficult to derive a real path fairly consistent with the data.

The radiant point is indicated at $192° + 4°$, or possibly $220° + 14°$, low in the eastern region of the sky. The height of the object was from about 71 to 23 miles along a path of 175 miles from over the neighbourhood of Vire in France to the English Channel, about 60 miles south of Eddystone. Velocity, 24 miles per second. The meteor seems to have been directed from a radiant comparatively unknown in March, but in April, contemporary with the Lyrids, there is a rich shower of slow and brilliant meteors from $200° + 8°$ near *o* Virginis.

The recent fireball must have passed almost vertically over Jersey, and from the Channel Islands and western parts of France it created a splendidly luminous effect. As viewed from Bournemouth the apparent size of the pear-shaped head of the meteor was considered to equal half the moon's diameter, which, from the distance of the object, would imply a magnitude of nearly two-thirds of a mile. This must have enormously exceeded the actual dimensions of the stony, or metallic, material composing the meteor. When undergoing combustion, the flame and expanding gaseous vapours from meteors give a vastly exaggerated idea of their real size. It must be very rare that a fireball exceeds one or two feet in the diameter of its material.

I have ascribed a flight of 175 miles to the recent fireball, but it may have been much longer than that. Many of the observers did not detect the object until it had developed considerable brilliancy. The moon was nearing the full at the time of its appearance, but the meteoric visitor startled some of the spectators with its astonishing lustre. W. F. DENNING.

THE INSTITUTE OF METALS.

VOLUME XII. of the Journal of the Institute of Metals, representing the work of the Institute during the second half of 1914, has just appeared. This is one of the first volumes of proceedings to appear since the outbreak of the war, and it indicates that the Institute of Metals has been able to pursue its activities, except for the fact that the autumn meeting which was to have taken place at Portsmouth early in September had to be abandoned. An interesting series of papers, however, are fully discussed by correspondence in the Journal. One of the most interesting from the scientific point of view is the paper by Mr. O. F. Hudson on the critical point at 460° C. in zinc-copper alloys. Mr.

Hudson brings forward evidence, which appears to be quite conclusive, that the interpretation of this point as marking the decomposition of the β phase of brass into $\alpha+\gamma$, which has been elaborated by Prof. Carpenter in a series of papers, is erroneous, and that the β phase merely undergoes a polymorphic change from β to β_1. A striking method of proof adopted by Mr. Hudson is that of preparing a series of alloys in a single piece of metal by the method of superposition. By superposing molten zinc on a layer of solid copper, the alloys can be formed at a temperature below 460° C., and yet a phase which corresponds to β makes its appearance. If what Carpenter has called "apparent β" were really unstable below 460° C., it could never be produced synthetically below that temperature.

Equally interesting from another point of view is the paper, and resulting discussion, by Mr. Arnold Philip dealing with the causes of corrosion in condenser tubes. In the recent Report to the Corrosion Committee of the Institute of Metals, Dr. Bengough and Mr. Jones had been led to reject entirely the view that particles of foreign matter, such as coke, which might set up local electrolytic effects, could thereby accelerate local corrosion and produce "pitting." Mr. Philip traverses this conclusion, and suggests that it was reached on insufficient evidence, while he adduces positive evidence to show that particles of coke can cause local pitting. While such divergence of views among those studying these matters is somewhat unfortunate from the point of view of the practical man seeking guidance for his practice, it serves to show the great need which exists for the further exhaustive investigation of such fundamental questions, and at the same time demonstrates the useful work of the Institute of Metals in encouraging such work and providing a meeting ground for full and—fortunately—dispassionate discussion.

Further papers of special scientific interest are those by Mr. S. W. Smith on the surface tension of molten metals, by Mr. Phelps on the effect of hydrogen on the annealing of gold, and by Messrs. Bengough and Hanson on the tensile properties of copper at high temperatures. In a "Note" Prof. Huntington also deals with the tensile properties of metals at high temperatures, but while Bengough and Hanson find in their results strong support for the theory that the crystals of a metal are held together by something of the nature of an amorphous cement, Huntington urges somewhat vague objections to that view.

Another "Note," contributed by Prof. Carpenter, deals with "The Extraction of Native Cooper at Calumet, Lake Superior"; while in itself not uninteresting, it is difficult to understand why this note has been included in the Journal of the Institute of Metals, since it deals with a subject outside the scope of its work and coming well within that of the Institution of Mining and Metallurgy. Although unimportant in itself, such a departure from accepted limitations causes confusion when references have to be looked up.

RECENT WORK ON INVERTEBRATES.

THE journal of a college of agriculture is about the last kind of periodical in which we should expect to find descriptions of deep-sea cephalopods. Nevertheless, three out of the four articles constituting the contents of the seventh number of vol. iv. of the Journal of the College of Agriculture, Imperial University of Tokyo, are devoted to new and rare species of squids, the remaining communication dealing with the eels of the Japanese, Corean, and Formosan seas. In the first of the three articles on squids, all of which are very fully illustrated, Mr. C. Ishikawa describes a new species of the genus Enoploteuthis from the Japan Sea, while in the second Messrs. Ishikawa and Wakiya treat of a number of fragments of a gigantic species taken from the stomach of a sperm-whale. The latter is identified with *Moroteuthis robusta,* of which it forms the fifth known example; in the third article the last-named writers describe a new species of the same genus under the name of *M. loennbergi.*

In an article, illustrated by one coloured and four black-and-white plates, in the February number of the *Entomologist's Monthly Magazine,* Dr. T. A. Chapman describes the larva of the butterfly *Everes argiades,* with figures, not only of the entire caterpillar, but also magnified representations of the shed skins at various stages of development. In the same issue Dr. D. Sharp continues his account of the beetles of the group Holophorini, dealing in this instance with the structure in the genital tube known as the ædeagus, which, as exemplified in *Meghelophorus aquaticus,* is described in great detail.

Aberrant modes of reproduction in certain well-known insects, such as the blue oil-beetle, the parasitic genus Stylops, and the vine-phylloxera, form the subject of an illustrated article by Mr. W. M. Scheyen in the January number of *Naturen.* A continuation is promised.

Writing in the January number of the *Zoologist* of non-sexual reproduction in sea-anemones, as observed at the Millport Marine Biological Station, Mr. R. Elmhirst remarks that although division is usually completed in a few days or weeks, especially among the members of the genus Anthea, yet that he has seen instances in which "double" individuals of Actinoloba showed no change during a period of several months. He also records a case in which an Actinia with two complete discs, mouths, and rings of tentacles retained the same form for close on four years in an aquarium. Possibly, of course, the somewhat unnatural conditions in such an environment may be a factor in these cases.

In *Spolia Zeylanica,* vol. x., part 36, Mr. A. Rutherford mentions that the females of a "glow-worm" (*Dioptoma adamsi*), in addition to the usual terminal light, have a number of other luminous points, apparently arranged in ten transverse rows. Somewhat similarly situated points of light also occur in the smaller males.

In the February number of the *Irish Naturalist* Mr. A. W. Stelfox gives a list of land and fresh-water molluscs from the Dingle Promontory, Kerry. Seventy-four indigenous species are recognised.

R. L.

MINERAL STATISTICS.[1]

PROBABLY the first point that will strike the student of mineral statistics when he sees the report now before us is the extreme dilatoriness of our Home Office. This report, which covers the mineral statistics of the world up to the end of 1912, was not published until the end of 1914; the Chief Inspector endeavours to excuse this delay by a reference to the lateness of the publication of official foreign statistics, but it is a significant fact that a private firm in the United States of America issued a large volume covering the world's mineral statistics for 1913 in July last, so that our own official production is no fewer than eighteen months behindhand. Statistics of mineral production are practically valueless unless they are published promptly, and all the

1 "Mines and Quarries. General Report with Statistics for 1912." By the Chief Inspector of Mines. Part iv., Colonial and Foreign Statistics.

information under this head afforded by the present publication has been common knowledge amongst all those interested for so long that it no longer presents any features capable of attracting attention.

The most interesting portion of the present report is accordingly that portion that deals with the labour employed in the world's mineral industry. It is shown that the number of persons engaged in this industry exceeded 6½ millions, more than one-third of whom were employed in the British Empire. It is interesting to note that more than one-half of this number was employed in coal mining, and as coal mining in different countries is more readily comparable than any other class of mining, because the conditions under which it is carried on present closer points of agreement, it may be profitable to compare briefly the labour statistics. Out of a total production of 1,250,000,000 metric tons of coal in the whole world, Great Britain alone produces 264,600,000 tons and the whole British Empire 314,500,000 tons, or about a quarter of the whole output. The other large producers are the United States with 484,900,000 metric tons; the German Empire, 255,800,000; Austria-Hungary, 51,700,000; France, 41,100,000; Russia, 31,300,000; Belgium, 23,000,000; and Japan, 19,700,000. It is curious to note that, with the exception of the United States, this list includes all the important nations engaged in the present war. The producing capacity of the miners engaged in this industry in metric tons per worker per annum is shown in the following table :—

Great Britain	230	United States	671
Australia	535	German Empire	272
Canada	486	Austria	307
India	129	France	307
New Zealand	511	Russia	142
South Africa	347	Belgium	157
		Japan	129

It will be seen that with the exception of India, where the labour is almost exclusively native, no part of the British Empire can show so low an output per head as does Great Britain itself, whilst of foreign countries it is only the smaller producers that rank worse than ourselves. In part, this small production is no doubt due to the fact that so many of our thicker and more easily wrought seams are to a large extent worked out, and that we are therefore compelled to work the thinner seams, from which a smaller output per man is necessarily produced. This drawback should, however, have been largely offset by the use of mechanical means for cutting and transporting coal, and it is difficult to avoid the conclusion that the low output is due to the restrictive policy covertly, it not overtly, encouraged by the Trades Unions.

It is some satisfaction to find that British coal mining is conducted with a great regard for the safety of the men engaged in this occupation. The death-rate per thousand workers employed is given as follows :—

Great Britain	1·17	France	1·49
British Empire	1·24	Russia	4·27
United States	3·26	Belgium	1·00
German Empire	2·44	Japan	5·64
Austria	1·48		

If the death-rate be compared, not per worker but per million tons of output, Great Britain will not appear in quite so highly favourable a light as compared with the United States, for example, that of the former being 4·66 deaths per million metric tons, and of the latter 5·44. Nevertheless, from every point of view our standard of safety may be looked upon as high.

It ought to be added that the above statements are calculated from the data tabulated in the report in question, which gives the figures for the various countries as though they were obtained in the same way, and therefore strictly comparable, which is far from actually being the case. Different countries use different methods of determining their mineral production, the number of men engaged in the industry and the number of deaths due to it, and the figures given are not therefore strictly comparable, though they may be expected to give a rough standard of comparison. One of the objects aimed at for many years by statisticians interested in mineral production was to get an international understanding as to the basis on which all these figures were to be determined, but now that Germany has in a few months destroyed the work of many years of European civilisation, and by her own relapse into barbarism has dragged all other nations down with her, any prospect of agreement on such minor international questions appears to be quite hopeless. H. L.

REPRODUCTION AND HEREDITY.

PROF. J. A. DETLEFSEN (University of Illinois) has made an important contribution to our knowledge of "Mendelian" inheritance by his "Genetic Studies on a Cavy Species Cross" (Carnegie Institution, Publication No. 205, 1914). The research —begun by Prof. W. E. Castle—is of interest as affording information from the crossing of two distinct species, for the wild Brazilian cavy (*Cavia rufescens*) is apparently sharply distinct from the common domestic guinea-pig (*C. porcellus*). The sterility of hybrid animals is known to be a rule admitting of many exceptions. In the experiments with cavies here described, crosses between *C. rufescens* males and *C. porcellus* females gave completely sterile male and fertile female hybrids. By mating the female hybrids with *porcellus* males, quarter-wild hybrids were obtained, again sterile males and fertile females; but by repeated back-crosses of female hybrids to *porcellus* males, individuals with increasing fertility were obtained. "Fertility seemed to act like a very complex recessive character; for the results obtained were what one would expect if a number of dominant factors for sterility were involved, the elimination of which would give a recessive fertile type." The paper is noteworthy because skeletal characters of the parents and hybrids are figured and compared, in addition to the usual external features, such as coat-colour.

A case of sex-limited inheritance in plants is discussed by Mr. G. H. Shull, who has made crosses between the typical *Lychnis dioica* and its variety *angustifolia* (*Zeitschr f. indukt. Abstammungs u. Vererbungslehre*, xii., 5, 1914). The narrow-leafed form is a recessive which reappears in half the males of the F_2 generation. All the F_2 broad-leafed males are heterozygous for the broad-leaf factor, while of the females half are heterozygous, half homozygous for this factor. As regards sex, the female Lychnis is a homozygote and the male a heterozygote.

Dr. Raymond Pearl continues his observations on the reproductive organs of domestic fowls. In a paper on the effects of "Ligation, Section, or Removal of the Oviduct" (*Journ. Exper. Zoo.*, xvii., 3, 1914), he states that these operations have no injurious effect on the growth of the ovary, and that after removal or closing of the oviducal funnel, eggs are passed into the body-cavity, where, if not absorbed at the peritoneal surface, they may cause "serious metabolic disturbances." In the *Journ. Biol. Chemistry* (xix., 2, 1914) Dr. Pearl informs us that injection of the desiccated fat-free substances of a cow's corpus luteum into a laying fowl at once inhibits ovulation. The possible practical importance of studies in heredity is shown by a short pamphlet from the annual report of the Maine Agricultural Experiment Station for 1914 on improving egg-production by breeding, and by a Bulletin (No. 110) of the U.S. Department of Agriculture (Bureau of Animal Industry), in which Dr. Pearl, with Dr. F. M. Surface, gives "A Biometrical Study of Egg-Production in the Domestic Fowl."

BACK TO LISTER.[1]

When Sir James Crichton-Browne, amongst whose many charms is a singular felicity of phraseology, invited me to undertake this task, he kindly supplied the title. It sounded rather startling, but as I could not think of a better, I humbly accepted it. It shows that I have no great discovery to announce, no new theory to propound, but only to take you back over old, well-trodden ground, to try to interest you in very technical matters, and to suggest that, in this particular case, reaction has overstepped the bounds of moderation, and that, as in many other fields, the most modern ideas are not always the best.

I will not trace the various steps by which Lister was led to his conclusions about the causes of suppuration and hospital diseases, nor draw a lurid picture of the deplorable mortality from these diseases before the introduction of the antiseptic system of treatment. I must, however, give you a short account of his first antiseptic method, which was founded on the discoveries of Pasteur, and explain in what way and for what reasons he afterwards modified it. If I succeed in making this clear it will be easy to understand how the relinquishment of much that he at first considered essential, but which later discoveries proved to be superfluous, led others to give up still more —much more than he ever considered it prudent to do. It will then be maintained that what he feared has come true: that the results obtained to-day, good though they are, are not so good as they would be if we were to return, perhaps not altogether, but almost, to those simpler and safer methods which Lister employed at the end of his active career.

Let us begin by trying to place ourselves in Lister's position during the years preceding 1865, when the writings of Pasteur were first brought to his notice. It was that of every thoughtful surgeon in those days. Of all the dealings of Providence with men—remember I am speaking of sixty years ago—not the least mysterious appeared to be the ordinance that the life-giving air, heaven's blessed breeze, without which life cannot be maintained for more than a few minutes, and on the purity of which man's vigour depends, should carry in some unexplained way the seeds of death and disease, being one day the doctor's greatest friend and the next his deadliest foe.

Physicians were quite sure that the acute specific fevers, such as scarlet fever and measles, were carried on the wings of the wind, and few had any doubt that cholera was borne by the same vehicle. Surgeons were equally certain that erysipelas should be placed in the same class as the acute specific fevers and that the suppuration of wounds depended upon the same agency. It seemed quite obvious, to anyone who thought about the difference in the behaviour of simple and compound fractures, that is, fractures with unbroken skin and those which are complicated by the presence of a wound. Except for this complication the fractures might be identical, but, in pre-antiseptic days, the presence of a wound was almost certain to lead to suppuration of a serious, if not a dangerous nature.

Old Glasgow students speak of Lister contemplating a simple fracture of the leg; the muscles torn and pulped, the limb swollen and shiny, black and blue, and pointing out to them that all this destruction of tissue and extravasation of blood would be surely and safely dealt with by the kindly influences of nature; but that the admission of the air through the smallest wound in the skin would completely change the prospect; the extravasated blood would soon stink, the injured tissues—bone and muscle—would die, and suppuration would take place, which might possibly infect the whole system. It did not enter into the mind of anyone, therefore, to doubt the morbific influence of the air. It was one of those things which appear so obvious that for a time they form the very foundations of belief, such as that the earth is flat and that the sun rises, matters which in more barbarous times laid sceptics open to the rigours of the Inquisition.

This was still the universal belief when Pasteur's discoveries were made known. Pasteur put the finishing touch to the work of many observers, who, during the first half of the last century, had been striving to find out what there was in the atmosphere which gave rise to fermentations of all sorts, and amongst others to that form of fermentation known as putrefaction. So long as fermentation and putrefaction were looked upon as chemical processes it was natural to suppose that one of the gaseous constituents of the air was the cause. But clear thinkers, like John Hunter, saw that this could not be the case.

There are two surgical conditions that prove this:—

(1) If a rib be broken and a sharp fragment injures the lung, large quantities of air may pass from the lung into the pleural cavity, but if the lung be healthy, decomposition never occurs in the putrescible fluid that is always present in the pleura in small quantity.

(2) If air passes into the cellular tissue of the body, as it sometimes does after the same accident, or some other injury of the air passages, large portions of the body may be distended by it to an extent that appears alarming. But again, as the air is effectually filtered on the way, decomposition does not occur and the evil result is only a temporary mechanical one.

Investigators, therefore, began to think that the cause of fermentation must be something solid and possibly living; something so small that it eluded their highest magnifying glasses, and so they adopted different lines of attack.

Some calcined the air, some filtered it, some passed it through causic fluids. There was an old French confectioner named Appert—Citoyen Appert, in the time of the Republic, who anticipated by many years the work of our modern fruit preservers. He succeeded in preserving all sorts of food in well-corked bottles by boiling them for various lengths of time according to the particular article he was dealing with; and his results were so nearly uniform and so remarkable, from an economic as well as from a scientific point of view, that they attracted the attention of the French Minister of the Interior in 1810, and also of the Académie Française.

Unscientific as these observations were, they gave an impetus to the work of chemists and biologists who carried out an enormous number of really scientific investigations in consequence. These were repeated by Pasteur, who made countless others of his own, of marvellous ingenuity. The results of his labours in this particular field before 1865 may be given in a tabular form. He showed that:—

(1) Putrefaction is a species of fermentation.

[1] Discourse delivered at the Royal Institution on Friday, March 12, by Sir R. J. Godlee, Bart., K.C.V.O.

(2) It is caused by the growth of micro-organisms and does not occur independently of them.

(3) The micro-organisms that produce fermentation and putrefaction are conveyed by the air on the dust that floats in it.

(4) These micro-organisms can be destroyed by heat and other agencies, or separated by filtration.

(5) Certain recognisable organisms produce definite and distinct fermentative processes.

(6) All of these organisms require oxygen. Some of them flourish only in the presence of free oxygen (aerobic), others only in its absence (anaerobic). The latter acquire their oxygen from the bodies which, by their growth, they are causing to ferment or putrefy.

(7) Many natural animal and vegetable products have no tendency to ferment or putrefy even in the presence of oxygen, if collected with proper precautions and kept in sterilised vessels.

(8) Spontaneous generation has never been observed to occur, and thus may be regarded as a chimera.

Now it will be observed that Pasteur's work presented Lister with two great fundamental facts.

(1) That putrefaction is caused by germs which can be destroyed by heat and chemicals and separated by filtration.

(2) That germs are carried by the dust in the air.

It is true that both Pasteur and Lister did not fail to recognise that if the air carried the germs it must deposit them upon the surface of everything, and that therefore the surface of every solid and the whole of every liquid must be, or might be, infectious. It is also true that Lister bore this in mind, and acted on the assumption that it was true from the very first. But still it was the air to which he paid and directed most attention—more attention, as we shall see, than it deserved. He probably did not recognise, he certainly did not say, that his precautions with regard to other sources of infection were far more important than those which he took with regard to infection from the air.

The sceptics and cavillers, the believers in spontaneous generation, kept saying, "Show us your germs in the air." They did not doubt that organisms were found in putrefying substances, they could not do that; but they said that they might be accidental, the result of putrefaction, not the cause of it, and asked for proof that germs existed in the air. Pasteur had tried to meet this objection by filtering the air through gun-cotton, which he afterwards dissolved and submitted the solution to the microscope. There were certainly objects which he was satisfied were germs, but the doubters were still unconvinced.

A few years later, about 1869, John Tyndall, whose eloquent addresses on "Dust and Disease" were listened to with breathless attention in this hall, succeeded in showing to the naked eye of untrained amateurs, the existence of, and the amount of, floating dust in any given sample of air, by passing through it a concentrated beam of light. Next he showed that, if the air was left undisturbed, say in a glass flask, the dust settled, and there was nothing for the beam to illuminate. Then he produced the same result by filtering the air, or by raising to a great heat a piece of platinum wire passing through the flask which burned up the dust. Finally, he proved, by a series of charmingly simple experiments, that what he called optically pure air was incapable of setting up decomposition in putrescible fluids, whereas optically impure air invariably caused them to decompose.

Most of these facts were known to Lister in 1865. All the evidence pointed in the same direction; and therefore, stated in the simplest way, the problem seemed to be to kill the germs which might have gained access to the wound before it came under treatment, and to prevent the air from carrying in others afterwards.

He first applied what he now called the antiseptic principle to compound fractures, injuries which, above all others, were liable to be followed by those hospital plagues—pyæmia, erysipelas, and hospital gangrene.

He had to choose between the three recognised methods of excluding the germs—filtration, calcining, and chemical antiseptics—and he naturally selected the last as the most convenient. The first antiseptic he tried was carbolic acid, and as the crude sample he first worked with was insoluble in water he used it undiluted.

His plan for treating compound fractures was, after cleansing the wound, to sponge the whole of the raw surface with this undiluted crude German creosote in order to destroy the germs introduced by dirt or other foreign material at the time of the accident, or that, as he supposed, had been carried to it by the air. The carbolic acid mixed with the blood, caused an antiseptic crust, which he fortified by covering it with a thin piece of block-tin, and this crust effectually prevented the access of unpurified air to the wound; for he left it undisturbed for days or weeks and painted the outside with more of the undiluted acid from time to time.

I wish to impress upon you that in the earliest dressings he used a very strong antiseptic and did his best absolutely to exclude the air, and it is important to note that his results were strikingly good, in spite of the fact that the undiluted acid did actually cause a certain amount of superficial sloughing—or death of the tissues—in the parts to which it was applied. As time went on a purer carbolic acid was obtained which dissolved in water, so he abandoned the caustic undiluted acid in favour of a saturated watery solution: 1 part to 20.

He soon extended the treatment, first to abscesses and then to ordinary operation wounds. The old antiseptic crust was soon given up, and various dressings containing carbolic acid or other antiseptics were employed instead. But for a long time he was so anxious about the air that he irrigated the wound with a solution of carbolic acid in water throughout an operation, and took the most elaborate precautions against allowing any air that had not been submitted to the influence of carbolic acid to reach the wound at the changing of the dressings. He used to say that merely taking out a drainage tube without antiseptic precautions involved a serious risk, because the air which rushed in to take its place might carry some speck of dust and a germ along with it.

In his most palmy days, when he was professor of clinical surgery at Edinburgh (1869–77), and Edinburgh was for the time the surgeon's Mecca, he introduced the spray in order to deal still more effectually with the air. In its most highly developed form the steam spray-producer threw a copious vapour, which was supposed to contain one part of carbolic acid in forty of water, that surrounded the whole region of the operation, and, if the room were small, might even fill the whole apartment with a pungent vapour, to the great discomfort of all concerned. He thought at the time that the momentary contact of the dust with the particles of carbolised water in the spray, or the carbolised atmosphere between the drops would be enough to destroy the germs; but in after years he owned that such a result was impossible.

At this period, though he was still using strong antiseptic lotions very freely, his results were yet more remarkable; and in the meantime, relying on the antiseptic principle, he was doing new operations which, without it, he would have considered to be altogether unjustifiable.

In spite of this, as you know, Lister's treatment, though hailed with acclamation abroad, met with a very ungenerous reception in this country. His compatriots could not understand the great principle that underlay it. They said that there was nothing new in it, or, if there was, it was bad. They said that their results were quite as good as his, or, if they were not, it was only because he paid so much personal attention to his cases. They gave the treatment silly names, showing that they had not grasped the meaning of it; at first it was the "carbolic treatment," now it was the "spray and gauze treatment." This last name was even adopted by Lister's disciples, and thus the spray came to be regarded as a fetish to such an extent that anything which cast a doubt upon its infallibility sorely tried the tender faith of the converted.

But increasing knowledge forced Lister to alter his own beliefs and greatly to modify his practice in the two particulars to which I have especially directed your attention. Thus he more and more diminished the strength of and the amount of his antiseptics; and, having become gradually convinced that infection from the air, far from being the greatest source of danger, was a negligible quantity, he gave up the use of the spray for good and all.

We must now inquire how this came about. Lister always looked upon an antiseptic as a necessary evil, because he saw that anything strong enough to kill germs must damage the living tissues. Therefore in quite early days he tried to do without antiseptics altogether, or at all events to admit nothing of the sort to the wound after the operation was finished. He also recognised from the first that healthy-living tissues had the mysterious power of preventing the growth of micro-organisms; and that this protective power was diminished by anything that lowered their vitality. He further pointed out that the vitality of the tissues varies in different individuals and in different parts of the body, as is illustrated by the well-known fact that healing takes place more readily in infancy than in old age, and in the face than in one of the limbs. The true meaning of this power was not then known. The explanation was given by the marvellous discoveries of Metchnikoff which Lister's own work prepared him to receive, when they were made known to the world.

Everyone now is familiar with the word "phagocytosis," but have you, ladies and gentlemen, really grasped its meaning? It is a sufficiently appalling thought that each one of us, who looks upon himself as a single individual, is only a huge joint stock company. We carry about with us millions and millions of other individual organisms—micro-organisms indeed—but each one endowed at least with life and definite individual functions. Some of them are apparently essential to the success of our bodies as a going concern. Many, even of these, are only waiting for some interference with the vitality of a part, or the whole, of our body, to afflict us with local or general disease, and finally to dissolve us into our elements.

Metchnikoff showed how these malignant organisms are kept at bay. Our very own body is made up of cells, each of which has, so to say, its individual existence and its special functions—almost its special intelligence—a fact which Lister was one of the first to demonstrate. Hosts of these cells—Metchnikoff's phagocytes—form, some of them, our main mobile army of defence. They are not like other defensive cells, such as those of the spleen and bone marrow, confined to their fortresses, though as a rule, they keep their allotted positions. But they can move along strategic railways to any special point of attack, and when they have reached it, there ensues a battle royal with the invading army of pathogenic organisms, which they try to swallow, and, if possible, to destroy. If they are successful, health is restored. It may mean the aborting of a cold in the head, the subsidence of a pneumonia, or the rapid healing of a cut. If, on the other hand, they are overpowered by the invaders, the catarrh may extend to the smallest bronchi, the pneumonia may end fatally, or the wound may suppurate with disastrous results.

These illuminating facts turned the attention of surgeons into another direction; and seeing that everyone knew that the vitality of the phagocytes must be impaired by any mechanical or chemical injury, the tendency was to reduce the strength of the antiseptics and to trust more and more to the phagocytes. Lister himself used weaker and weaker antiseptic lotions, but he never thought it wise to dispense with them altogether. Others, however, being chiefly obsessed with the notion that chemical antiseptics diminish the power of the phagocytes, maintained that their use should be altogether discontinued, and have adopted, or say they have adopted, a treatment which, though having the same object as Lister's, is supposed to be founded upon a different principle. How far this is actually the case it will presently be our business to inquire.

This was one of the reasons why it began to be said that Lister's teaching, like the Old Testament, was obsolete, and must be replaced by a newer and more perfect gospel.

We must now further consider how far the air is really a source of infection. In the early days it was said that the number of germs in the air was enormous. As a matter of fact, such a statement is still true, as is easily shown by exposing a plate of cultivating medium in any room, say in the most up-to-date modern operating theatre.

It was also taken for granted that the large majority of germs were pathogenic—that is, disease producing. But very little was known, in 1865, of the varieties of micro-organisms. It is true that Pasteur had isolated various yeasts or ferments, and had shown that some organisms were aerobic and some anaerobic, and that the words vibrio and bacterium were beginning to be used. But as time went on two very important facts were made out. *First*, that only a small proportion of the flora of the air are pathogenic; and, secondly (and this was one of Lister's own discoveries), that great dilution of a septic fluid very much diminished its chance of infecting a putrescible medium. Thus typhoid pollution of the Nile in a few miles ceases to be a source of danger, and one or two septic organisms introduced into a vessel of blood serum will fail to grow. It is really masses of particulate dirt which are dangerous, because they contain colonies of organisms adequately protected from attack. And, if this applies to attempts at infection of vessels containing blood serum, still more does it apply to the dropping of isolated staphylococci and streptococci on to a wound where the greedy phagocytes are lying in wait to devour them. At every operation scores of germs fall upon a wound—hundreds if it be prolonged—but most of them are those of moulds and other innocuous vegetables which have no chance of growing there; and although there is a possibility of an occasional pathogenic organism being among the number, the risk of its developing is so small, that it is now generally considered to be negligible, and that if one or two should escape into the lymph channel, they will never elude the phagocytes in spleen or bone marrow or elsewhere.

I must now explain how the spray helped to prepare Lister for the acceptance of Metchnikoff's discoveries.

I said it was unpleasant for all. There were some surgeons to whom it was positively poisonous. Amongst these was a friend of Lister's, Thomas Keith, the ovariotomist, whose field of operation was, of course, the peritoneal cavity. In pre-antiseptic days he had obtained results that had astonished the world, by dint of great dexterity, devoted personal attention, and scrupulous regard to cleanliness. His success tried the faith of some, but not of Lister, who was aware of the specially high vitality of the peritoneum, and of other anatomical and physiological peculiarities which diminish the chance of survival of germs, but which are too technical for discussion here.

Keith's success was so great that he hesitated to adopt rigorous antiseptic methods, and Lister at first dissuaded him from doing so, fearing that carbolic acid might dangerously interfere with the vitality of the peritoneum. Besides, at that time he did not fully trust the efficacy of the spray. Keith did, however, for a time use all Lister's methods, including the spray; but this seriously interfered with his health, so he abandoned it, and yet, when he gave it up, his results continued to be as good as when he was using it.

The germicidal powers of the peritoneum are great, but they are only in degree greater than those of muscle, fat, and other tissues. And when it was found that other surgeons, some of them keen disciples, were absolutely forced to give up the spray, or give up surgery, and that, when they chose the former alternative, their results were no worse than before, Lister at last came to the conclusion that the spray was unnecessary, even if it had really made an antiseptic atmosphere, but, as I said before, he now saw that this was impossible. The spray was really only a convenient, unconscious, automatic irrigator. It killed germs on the wound, not in the air, and as such had been very useful during the time when the lesson was being gradually learned that every surgical operation, every surgical dressing, is, in fact, a complicated bacteriological experiment.

The mitigation of the strength of the lotion and the abandonment of the spray seemed to some like lowering the standard. But it was not so. It was not so because the principle remained unshaken, namely, that as organisms are the cause of putrefaction they must be excluded from a wound, or if they had gained access to it they must be destroyed or prevented from growing. Two changes of method had indeed been introduced:—weaker antiseptics were employed because greater respect was paid to the defensive powers of the body, and the spray was given up because opinion had altered with regard to the importance of aerial attacks. Aircraft came to be disregarded, while it was seen that what may be compared to land and water attacks were far more dangerous. The germs on the skin of the patient, the dirt on the hands of the surgeon, the unpurified sponge, the dried clot on a badly cleaned instrument; these were the dreadnoughts and submarines; these were the sappers and miners, the howitzers, and hand-grenades that really decided the fate of the campaign. Thus it became obvious that the precautions taken against such sources of danger, which, though they were adopted from the first, had been overshadowed by the attention devoted to the air-raids, were really of far more vital importance; and much ingenuity was thenceforward devoted to devising means for purifying the skin by mechanical or chemical means, to inventing gloves which would not impair the sense of touch, and also to proving that there was a radical difference between aseptic and antiseptic surgery.

We now come to the question of what is meant by aseptic as opposed to antiseptic surgery. Aseptic is no new word. Lister employed it quite early in his writings, and, though it is plain to see why he called his system antiseptic, it is almost to be regretted that he did not call it aseptic. It would have prevented the confusing suggestion that, as Hunter and others had spoken of and used antiseptics, his system was nothing new, and perhaps it might have saved us from the still more confusing suggestion that there is some fundamental antagonism between aseptic and antiseptic treatment, though they are really the same.

Those who call themselves aseptic surgeons maintain that they do not employ chemical antiseptic agencies. The idea started amongst the gynæcologists who, as has been shown, were working under peculiarly favourable conditions as regards asepsis. They were supposed to use only mechanical means in striving after cleanliness—washings and scrubbings and so forth, which do, of course, remove the deadliest form of danger, particulate dirt. But even these surgeons, or some of them, used to employ freely the most potent of all antiseptics, heat. They boiled their instruments and boiled the water with which they washed out the peritoneal cavity, and some were in the habit of using a pretty powerful antiseptic, sulphurous acid for purifying those most dangerous things, sponges.

Let us now watch an aseptic surgeon at work. Somewhere in the background there must be a very large steriliser for superheating overalls, caps, veils, towels, dressings, and bandages; also a boiler for boiling instruments, and an unlimited supply of boiled (he calls it sterilised) water and normal salt solution.

He spends a long time in scrubbing his hands in soap and water, and probably in spirit of wine, which is an antiseptic; he then puts on his sterilised overall, cap, veil, and india-rubber gloves. Thus, converted from a dangerous into a harmless character, he ought never to touch any contaminated object. But it is to be feared that he sometimes forgets the meaning of his vestures: that he wrongly looks upon them as armour, and, inspired by this confidence, he touches the unclean thing, and then puts his fingers into the wound.

One may be forgiven a passing smile at the unreasoning way in which these details are followed out. Surgeons dress themselves up like white-robed priests to examine the external ear, or to explore those parts of the body that no process on earth can render even approximately aseptic.

But to return to our aseptic operation. The instruments, having been boiled, are commonly placed in a tray containing boiled water. Why I have never been able to discover. They would be equally safe if used dry. Probably it is only an imitation of Lister's plan of sterilising his instruments in a tray of carbolic acid lotion.

The patient's skin is almost always purified by a chemical antiseptic, sometimes alcohol, but now usually tincture of iodine. The part to be operated on is then surrounded by superheated dry towels, and the operation proceeds. Superheated swabs have replaced marine sponges. No antiseptic is applied to the wound. Plain boiled water or boiled saline solution is used for washing away clots; preferably saline solution, because it does not interfere with the living cells by osmosis as plain water does.

When the operation is over, a dressing of superheated gauze and wool is fixed by a superheated bandage or by plaister. This, of course, only acts as a mechanical filter of dust, but it is now looked upon with reverence, as if it had some other special virtue, and you may see it applied with extraordinary precautions to septic suppurating wounds and kept on for twenty-four hours, regardless of the fact that it becomes a septic dressing immediately after application; that it is, in fact, nothing but a beautifully whitened sepulchre full, if not of dead men's bones, at all events of all uncleanness.

Some aseptic surgeons apply their principle to compound fractures and rely solely on mechanical means for removing dirt from the recesses of the wounds; but most, I believe, continue to employ powerful antiseptics for this purpose, and in this class of injury follow Lister's instructions.

I am not so ignorant or bigoted as to suggest that so-called aseptic surgery is a bad way of treating wounds. I know that first-rate results are constantly obtained by means of it. But, I maintain, and here I am repeating what Lister often said to me:—

(1) That it is a troublesome and difficult process, involving for successfully carrying it out an amount of paraphernalia and an amount of training that puts it almost beyond the reach of all except hospital surgeons.

(2) That it is misleading to set it up in opposition to the antiseptic system, because most of its advocates use chemical antiseptics for one purpose or another, and all employ heat with great freedom.

(3) That infections of the skin and consequent later suppuration is more likely to occur than if Lister's methods are followed.

I will now describe one of Lister's operations in his last years at King's College. He did not require a huge autoclave for sterilising. He did not wear gloves, but he purified his own hands and the skin of the patient by a most potent antiseptic, which was called the strong mixture. It consisted of 1 to 20 carbolic acid in 1 to 500 corrosive sublimate. Lister, fortunately or unfortunately, had a very resisting skin; his hands, however, were usually rough, but he did not seem to mind. This was not the case with many of his followers, who could not, or would not, stand the discomfort strong lotions produced. This has undoubtedly been one cause of secession. The instruments and the sponges (he used marine sponges) had been long steeped in strong carbolic acid lotion, but during the operation they were wrung out of a very weak antiseptic solution. The towels placed round the field of operation were also carbolised. No irrigation was carried out. When the operation was complete, a dressing containing an antiseptic substance was applied.

His treatment of compound fractures was never modified after the first few years.

The differences you see are these:—

(1) Lister trusted to a potent chemical antiseptic, instead of to mechanical cleansing and heat, for sterilising the skin, instruments, and the objects likely to be brought into contact with the wound.

(2) He applied a very weak antiseptic in small amount to the wound itself, instead of boiled water or normal saline solution.

(3) Instead of plain gauze he used an antiseptic dressing, which has the great advantage of acting upon any organisms that, after the operation may reach the surface from the sweat and sebaceous glands of the patient.

These differences between the two systems, as thus stated, do not appear to be great, but they are important. "The little more, and how much it is! and the little less and how far away!" For in one there is simplicity and safety, in the other complication and risk. Thus in the first place sterilising by a chemical antiseptic involves no special apparatus. It can be carried out in the humblest cottage. Secondly, the use of an antiseptic during the operation does away with the necessity of the surgeon and his assistants, young dressers, or busy country doctors, or nurses being constantly on the *qui vive* lest their simply aseptic garments should touch some unpurified thing and then convey defilement to the wound. Thirdly, security is provided for against secondary infection from the skin; or secondary infection through the dressing, if the discharges should soak through to the surface and thus supply a neutral track for the germs to travel along.

When I come to speak of results I must necessarily be vague. I have, however, formed the opinion, from much observation and long experience, that the standard as regards suppuration amongst aseptic surgeons is lower than Lister's used to be. If a case "goes wrong," as the common but mischievous expression is, it is looked upon as an unavoidable accident, not as a disgrace. In recent years the term, "stitch abscess," has sprung into use. Lister said he never had stitch abscesses. Forgive me for dwelling on them for a moment. The name is applied to suppurations occurring about stitches, and they arise in this way. Our skin is full of small glands for supplying greasy material to the hairs. Organisms are present in these glands, and any weakening of the tissues gives them a chance of doing mischief, the commonest illustration of which is the ordinary boil that starts from the fretting of a cuff or a collar. A tight stitch, or a not very tight one, may do the same. But the risk is very much diminished by thorough purification of the skin, which is much more effectually obtained by following Lister's instructions than by "aseptic" methods. It may be granted that stitch abscesses do not often lead to serious mischief, but they often cause troublesome suppuration in the wound itself and involve delay, and the removal of important deep stitches, which were intended to be permanent. This risk is also lessened by using an antiseptic as opposed to an aseptic dressing. I confess I have never been able to understand the objection to an antiseptic gauze dressing. If the wound heals by first intention the antiseptic substance cannot possibly act upon the raw surface of the wound. Antiseptic gauze has all the advantages of sterilised gauze except that it is slightly more expensive and has none of its disadvantages; in fact, I am confident that it has only been discarded on purely theoretical grounds.

To what extent, then, should we return? I would not urge the use of marine sponges, because they are difficult to clean and expensive, and because cotton swabs are equally efficient. Nor would I recommend the giving up of india-rubber gloves, although I know that they have their dangers, and although I know that they may safely be dispensed with by an antiseptic surgeon. Boiling instruments, I think, should be continued. Otherwise I say that it is only fair to students to tell them, and show them, that by carrying out Lister's technique, it is more easy to obtain the very best results and less likely to fail.

I have only spoken of civil practice, but I would not have ventured to offer you a surgical address, and I could not have hoped to attract your attention if it had had no bearing upon the war which is now raging.

Lister's faithful followers had not only watched with regret what they considered to be a retrograde step in civil practice, but they feared that a war would bring out in relief its weak points.

Wars have occurred of late in distant parts of the world, but we paid little heed to the details. It required a war in our midst, with our own flesh and blood in the trenches exposed to the bullets of the foe, and to the pestilence that walketh in darkness, to bring the matter really home to Englishmen. And when it came, the reports from the front of almost universal sepsis made us fear that our prognostication had come true, and that the abandonment of antiseptics was, at least in part, accountable. It appears, however, that antiseptics are being very largely used, though with most disappointing results.

The fact must not be overlooked that military surgery is exceptional, and that this particular war is being fought in most exceptional circumstances—trenches dug and monster shells exploding in the highly-cultivated soil of a noted tetanus area like the valley of the Aisne. It is almost impossible for us at home to appreciate what is going on. Listen, therefore, to this graphic extract from a letter I received last week from Sir Anthony Bowlby:—"In this trench warfare you must remember that, if a man is hit, he often falls into filthy mud and water, which may be 3 ft. deep or more. Remember also that the trench is only $2\frac{1}{2}$ ft. wide. *If it is night,* you can only grope about in the dark and can do no dressing of any kind, for you can't even get any clothes off in the dark, and in so cramped a space, and you must try to get the man away to a 'dressing station' half a mile distant, and thence to a field ambulance. *If it is daylight,* you can't get the man out of the trench at all, and he may have to be kept there for many hours, because he would certainly be killed if he was got out of the trench. And the water in the trenches is hopelessly polluted, and soaks his clothes and his wound. It is only too evident that large lacerated wounds, and especially bad bone smashes, are so contaminated that it can never be possible to render them aseptic."

This is a dreadful picture; but all fighting is not trench fighting, and we might have hoped not to be told that all wounds, except bullet wounds, are septic, seeing that a few, at least, come under treatment within a reasonable period, say twelve hours, after infliction.

I have been helping Sir Watson Cheyne to lead a crusade in favour of applying to these dirt-infected wounds Lister's original method of purification by means of undiluted carbolic acid. Not that I advocate it for civil practice, but because I think that the only chance of destroying the organisms of tetanus and gas gangrene, and the best way of dealing with streptococci, is to use the most potent and safest antiseptic which is at the disposal of the surgeon for the purpose.

The suggestion met with the cordial approval of those who, like myself, have employed this agent extensively. But it excited a certain amount of loud criticism from others, who were chiefly impressed by the fact that undiluted carbolic acid produces a certain amount of sloughing. This criticism is easily met, because, if employed with the discretion that may be expected of reasonable people, the slough is unimportant, superficial, and antiseptic—incomparably less suited for the growth of micro-organisms than the extensive and spreading sloughs which they themselves produce. Moreover, these antiseptic sloughs do no harm, but are quickly absorbed if the wound heals antiseptically.

That is not the weak point in the argument. There is, however, another, more difficult to answer, of which our opponents did not make so much. Unfortunately, it cannot be denied that the spores of the bacilli of tetanus resist the action of even undiluted carbolic acid for a very considerable time. Moreover, my colleague, Dr. Thiele, has shown that, if easily recognisable micro-organisms are injected into the subcutaneous tissue, they enter the lymph channels, and may pass into the circulation in the course of a few minutes, long before there is a chance, if the same thing happens in contused wounds, of getting at them with our antiseptics.

Are we, then, to abandon this line of treatment, to fold our hands in despair and say that it is useless to attempt to disinfect any wound in civil or military practice to which spore-bearing or other organisms may have gained access? By no means. All Lister's work cries out against such a conclusion. We must clear our minds of the delusion that carefully planned experiments on guinea-pigs in the laboratory are on all fours with unrehearsed experiments in factories, or on wounded soldiers in the battlefield. Lister did undoubtedly succeed in stopping sepsis in compound fractures and in banishing tetanus and hospital gangrene from his wards, and the experience of generations of surgeons working with a saturated watery solution of carbolic acid has confirmed his conclusions. Surely, then, it may be possible to find a practical way of applying the principle to military practice.

It will not, however, do to brush the argument aside in this way without examining it and answering it. I therefore submit for your consideration a suggestion as to what happens in a case successfully treated antiseptically, that is, one that heals without suppuration.

We do not know for certain in what form the anaerobic spore-bearing organisms are introduced into a wound. I, at all events, do not know of scientifically conducted observations upon the subject. But it is clear that they must be either in the form of bacteria, or spores, or both, probably embedded in decaying organic matter in the soil. If the antiseptic reaches them it destroys the bacteria, together with the other septic organisms. But possibly, or, let us say, probably, it has not sufficient time before becoming too diluted to kill the spores, though it may for a while inhibit their power of development. There, then, these spores lie dormant between a thin layer of carbolised slough and a mass of more or less carbolised blood clot. If sepsis is avoided, the phagocytes at last invade both the slough and the clot, and healing takes place without suppuration. What is the fate of the spores?

We must suppose that, when the carbolic acid has disappeared, as they are embedded in a warm, airless nidus, they germinate, but only to find themselves surrounded by active phagocytes which, if they form a suitable pabulum, destroy them. And so the matter ends so far as the wound is concerned.

This, I maintain, is a reasonable hypothesis and a sufficient answer, and fortunately it is rare indeed, if it ever happens, for tetanus to occur *after* a wound has healed without any suppuration at all; and, moreover, the abolition of tetanus in civil practice has coincided with the reduction in the number of suppurating wounds.

As a further support of the argument, let us now consider the case of the bacteria and spores of tetanus or gas gangrene lying together in an untreated wound, or in one to which less powerful antiseptics are applied, antiseptics not strong enough to destroy the pus-producing organisms. They find themselves, therefore, amongst extensive septic sloughs and decomposing blood-clots in which the phagocytes, if they can penetrate at all, have their time fully occupied with myriads of other organisms, which first weaken and then overpower them. Is it to be wondered at that lockjaw and gas gangrene affect a certain proportion of such cases? On the contrary, the marvel is that these complications are not more frequent.

For, after all, though tetanus and gas gangrene are ghastly things, and make a great impression because the laity knows about them, these diseases are not by any means the most deadly or the most frequent. Probably 40 per cent. of the wounds at one part of the campaign were infected with tetanus, but, up to date, there have been reported only 207 cases, of which only 2 have occurred since January 20. And it must be remembered that there are effectual ways of dealing with both diseases—tetanus by the prophylactic administration of antitetanic serum, and gas gangrene by very free incisions.

No, the deadliest enemy is the ubiquitous streptococcus, the foe that kills more than shells and bullets. But as it is certainly killed by undiluted carbolic acid or by a 5 per cent. solution in water, there is at least a chance that, so far as streptococci are concerned, wounds may be disinfected even in war, and if these and the other pyogenic organisms are destroyed, there is, as I have shown, great reason to suppose that sporing anaerobes like *Bacillus tetani* would have no chance of growing.[2]

But it may be said: "What about the organisms that have entered the lymph channel and the blood current? What is the good of trying to purify the wound if they have already given us the slip?"

Let us see precisely what Dr. Thiele says, and remember that his experiments are conducted by injecting cultivations of micro-organisms subcutaneously. He maintains:—

(1) That they travel quickly to the nearest lymphatic glands, where they are retarded, perhaps killed.

(2) If not, they make their way along the thoracic duct to the jugular vein and enter the blood stream, and by that channel are conveyed, a few at a time, not in sufficient numbers to be detected by the microscope, to the bone marrow, the spleen, and other parts where groups of cells of the phagocyte class are ready to deal with them.

(3) If the enemy overpowers all these means of resistance they may invade the blood in large numbers and cause general blood-poisoning.

(4) That some are quickly taken up by the blood without passing through the lymphatics.

I must again point out that, in spite of all these alarming facts, general septicæmia probably never occurs if the wound heals without suppuration. To take another simile from the war, the germs that escape into the circulation are like enemy aliens, prisoners of war, or the struggling Turks who crossed the Suez Canal. It is not they, but the main body on the fighting line—that is, the wound—who are engaged in manufacturing the deadly toxins. If they can be annihilated, there is not much fear of mischief from the enemy in our midst. It has never been suggested that germs which have entered the circulation from the wound go back with their ill-begotten progeny to make it suppurate. The argument, therefore, that it is useless to try to make wounds aseptic because some germs have already escaped into the circulation is no stronger than that founded on the resisting powers of spores to the action of antiseptics. Both are the arguments of the bacteriologist rather than of the practical surgeon, and, whilst being treated with all respect, they must not be estimated above their true value.

I cannot hope that your patience is not exhausted. But I trust that you are now convinced of the real danger that may result from neglecting Lister's teaching both in civil and military practice.

As to the latter, which for the moment occupies almost all our thoughts, I should be the last to say that there is only one way of salvation—that, for example, corrosive sublimate is dangerous, or iodine untrustworthy, or peroxide of hydrogen of little value. Still less would I say that military and civil surgery should be run on the same lines. But I still think that undiluted carbolic acid is, according to our present lights, the antiseptic most likely to be practically useful in the rough-and-tumble practice of the battlefield.

And whether or not this may turn out to be the conclusion of our gallant brethren at the front, I would add that the experience of the present war is one of the strongest arguments for rallying to Sir James Crichton-Browne's battle-cry, "Back to Lister."

Long ago it was prophesied that science would stop war by making it too horrible. Are we nearing that blessed result? One fact stands out in spite of the faint hopes I have expressed—that nothing can stop sepsis in war except stopping war altogether.

[2] In using the word anaerobe I desire to own that I do not completely understand its meaning. It certainly has been used in more than one sense, and to-day bacteriologists are not agreed about the effect of oxygen on anaerobes, their need for it, the sources from which they obtain it, and other points. We cannot divide micro-organisms by a clear cut line into aerobes and anaerobes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. W. L. Mollison has been elected master of Clare College, in succession to the late Dr. E. Atkinson. He was Second Wrangler in the Mathematical Tripos of 1876, and Second Smith's Prizeman, and was elected a fellow of Clare in that year. Afterwards he became successively junior tutor and senior tutor, and was at one time moderator and examiner in the Mathematical Tripos. He was made an Honorary LL.D. of the University of Aberdeen in 1897.

London.—Mr. L. W. King, assistant keeper of the Egyptian and Assyrian department of the British Museum, has been elected professor of Assyrian and Babylonian archæology at King's College. Mr. King's professorship will be a part-time post, and he will retain his position at the museum.

Dr. F. Wood-Jones, lecturer and head of the department of anatomy at the London (Royal Free Hospital) School of Medicine for Women, has been granted the title of professor of anatomy in the University.

We learn from *Science* that Robert Flersheim has left a bequest of a million marks to the University of Frankfurt.

The Rockefeller Foundation has, says *Science*, made comprehensive plans for improving medical and hospital conditions in China. The plans are based on the report of the special commission sent by the foundation to China. To carry out this work the foundation has established a special organisation to be called the China Medical Board of the Rockefeller Foundation, of which Mr. J. D. Rockefeller, jun., is chairman. The plan outlined by the commission provides for the development of medical education in China as the first step. With the view of building up a body of Chinese medical men able to teach medical science, the foundation has decided to establish six fellowships, each of 200*l.* a year and travelling expenses, to enable Chinese graduates to study abroad. Six fellows have been appointed, one of whom is already studying in the United States.

The new buildings of the Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh were formally opened on February 26 last. The institute, which cost 75,000*l.*, was the gift of Messrs. A. W. and R. B. Mellon, of Pittsburgh; it is provided with complete facilities for the investigation of manufacturing problems and for conducting industrial research in accordance with the system of co-operation between science and industry, founded by the late director of the institute, Dr. R. K. Duncan. By this system, a manufacturer having a problem requiring solution may give a fellowship to provide the salary of a researcher selected to carry out the investigation desired, the institute supplying every facility for the work. At present twenty-three fellowships are in operation and forty research chemists are at work. At the opening ceremony fifteen honorary degrees were conferred on distinguished Americans. Though the institute possesses its own endowment and has its own board of trustees, it is an integral part of the University of Pittsburgh.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, March 23.—Mr. R. H. Burne, vice-president, in the chair.—R. **Lydekker**: The true coracoid. The element in birds and post-Triassic reptiles universally known as the coracoid is the homologue of the human coracoid process, and its equivalent the true coracoid of the monotremes and mammal-like reptiles.—Dr. F. E. **Beddard**: Certain points in the anatomy of the Cestode genera Amabilia and Dasyurotænia.—B. F. **Cummings**: New species of Polyplax (Anoplura) from Egypt. This paper contained a systematic description of two new species of louse based on a large supply of material in spirit collected on *Acomys cahirinus*, Des., and forwarded by the Department of Public Health in Egypt to the Lister Institute, by whom they were subsequently presented to the British Museum. Both the new species were fortunately collected in large numbers in all stages of development, and an account of the larvæ consequently has been prepared.—J. T. **Cunningham**: The resemblance in form and markings of the plates of paraffin-wax originally obtained by Prof. Kappers, of Amsterdam, to the shells of Molluscs. Examples of these structures had been exhibited at a previous meeting by Mr. R. H. Burne. Mr. Cunningham found that the forms were produced by pouring molten paraffin-wax on to the surface of cold water, and he had no doubt that Prof. Kappers's specimens were produced in the same way by the molten wax running over on to a vessel filled with water. The author concluded that the form and markings were not in either case in any way due to effects of crystallisation as Prof. Kappers supposed.

Geological Society, March 24.—Dr. A. Smith Woodward, president, in the chair.—P. G. H. **Boswell**: The stratigraphy and petrology of the Lower Eocene deposits of the north-eastern part of the London basin. The following divisions of the Lower Eocene occur in the area:—London Clay—basement-bed only; the Pebble-Beds and accompanying sands; Reading Beds; Thanet Beds. The unconformity of the Eocene upon the Chalk is discussed, and reasons are given for regarding the layer of green-coated flints at the bottom of the Thanet Beds in the area as a true basal conglomerate. Evidence is adduced to show that the London Clay overlaps the Lower London Tertiaries, and rests directly upon the Chalk in Norfolk. The Reading Beds also overlap the Thanet Beds in the western part of the area. A hypsometrical map of the Chalk-surface in the London Basin is presented, and a minimum estimate of the unconformity, in terms of thickness of Chalk removed, is given for the northern part of the basin. Stratigraphical details of the various divisions and descriptions of new sections are given. The variations in lithology of the Reading Beds are described, and it is shown that the Pebble-Beds belong lithologically and petrologically to the Reading Beds, but that their scanty fauna is a London Clay one. The distribution of the sarsens in the area is plotted out on a map, and their petrology is considered; it is concluded that, in this district, they are derived from the sands of the Reading Beds. The mineral constitution of the various divisions of the Eocene Beds is discussed in detail.

Manchester.

Literary and Philosophical Society, March 9.—Mr. F. Nicholson, president, in the chair.—Sir Ernest **Rutherford**: Origin of the spectra given by β and γ rays of radium. An account of recent experiments by Sir Ernest Rutherford and Dr. Andrade to determine the wave-length of the very penetrating γ rays emitted from radium. The spectrum of the γ rays was obtained by a photographic method by reflecting the rays from a thin slip of rock-salt. The radio-active source consisted of a fine glass tube containing a large quantity of radium emanation. Special precautions were taken to get rid of the effect of the β rays emitted with the γ rays. A large number of lines were observed in the spectrum over a wide range of wave-length. Two well-marked lines are reflected from rock-salt at 10° and 12°, and correspond to some soft γ rays. There were other strong lines of 1° and $1{\cdot}7^\circ$, corresponding to the very penetrating rays. The shortest wave-length observed was 0·7 Angström unit, which is about 1/50,000 of the wave-length of visible light. This radiation has much the shortest wave-length at present known. An account was also given of the methods for determining the magnetic spectrum of the β rays. The rays from a fine source, passing normally in a strong magnetic field, describe a circular path and fall on a photographic plate. A number of well-marked lines are observed on the plate, which correspond to groups of rays of definite velocity. The speed and energy of the β particle comprising each of those groups of rays from radium products have been accurately determined by Rutherford and Robinson. The general evidence indicates a very close connection between the emission of β and γ rays from radio-active bodies, and that the energy of the groups of β rays are intimately related with the frequency of the γ radiation from which they arise. The author outlined a general theory to explain the connection between the β and γ rays.

Paris.

Academy of Sciences, March 29.—M. Ed. Perrier in the chair.—Edmond **Delorme**: Artificial limbs for the use of the amputated. Medical treatment is required by the amputated for some time after the wound has healed, if the full benefit of artificial limbs is to be obtained.—J. Comas **Solá**: Certain rapid displacements of short duration registered by photography. In photographs of the sky taken for the purpose of detecting minor planets, a certain number of stars showed changes of position from hour to hour, which could not be attributed to contractions or deformations of the gelatine of the plate.—J. Comas **Solá**: The discovery of a new minor planet.—E. **Keraval**: A family of triply orthogonal systems.—Gaetano **Scorza**: Singular Abelian functions.—M. **Dussaud**: New experiments on sources of light of small surface.—O. **Bailly**: The constitution of glycerophosphoric acid and of lecithin. Egg lecithin is a mixture of two isomers from which a mixture of α- and β-glycerophosphoric acids is obtained, the latter predominating.—G. **Tizzoni**: The infectious nature of pellagra. Results of researches made in Italy and in Bessarabia. Further studies on the micro-organism previously described by the author under the name of *Streptobacillus pellagrae*.—M. **Guépin**: The destruction by suppuration and ablation of a considerable part of the brain resulting in no appreciable trouble.—Pierre **Delbet**: Extra-pericardic cardio-thoracic symphysis.—H. **Busquet**: The comparative pharmacodynamical action of gold in the colloidal and soluble states. So far as gold is concerned, the qualitative reactions on the heart are quite different in the colloidal and dissolved conditions.—B. **Collin**: *Chromidina elegans*.—E. **Kayser**: Contributions to the study of the ferments of rum.

BOOKS RECEIVED.

Descriptive Geometry for Students in Engineering Science and Architecture. By Prof. H. F. Armstrong. Pp. vi+125. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

Structural Steel Drafting and Elementary Design. By C. D. Conklin, Jun. Pp. vii+154. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 10*s*. 6*d*. net.

Canada. Department of Mines. Mines Branch. Economic Minerals and Mining Industries of Canada. Pp. vii+78. The Physical Properties of the Metal Cobalt. Part ii. By Dr. H. T. Kalmus and C. Harper. Pp. vi+48. Report on the Building and Ornamental Stones of Canada. Vol. iii. Province of Quebec. By Dr. W. A. Parks. Pp. xiv+304. (Ottawa: Government Printing Bureau.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1914. Pp. 404+Appendix. (London: H.M.S.O.; Wyman and Sons, Ltd.) 4*s*. 6*d*.

Smithsonian Institution. U.S. National Museum. Report on the Progress and Condition of the U.S. National Museum for the Year ending June 30, 1914. Pp. 252. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Bulletin 89: Osteology of the Armored Dinosauria in the U.S. National Museum, with special reference to the genus Stegosaurus. By C. W. Gilmore. Pp. xi+143. (Washington: Government Printing Office.)

A Chaplet of Herbs. By F. Hine. Pp. xv+168. (London: G. Routledge and Sons, Ltd.) 2*s*. 6*d*. net.

The Potamogetons (Pond Weeds) of the British Isles, with Descriptions of all the Species, Varieties, and Hybrids. By A. Fryer and A. Bennett. Pp. x+94+60 plates. (London: L. Reeve and Co., Ltd.) 5 guineas net.

Floral Rambles in Highways and Byways. By Rev. Prof. G. Henslow. Pp. v+294. (London: S.P.C.K.) 6*s*. net.

University of Pennsylvania. The University Museum Anthropological Publications. Vol. vi., No. 2: The Dance Festivals of the Alaskan Eskimo. By E. W. Hawkes. Pp. 41. (Philadelphia: University Museum.)

Annual Report of the Board of Regents of the Smithsonian Institution, 1913. Pp. xi+804. (Washington: Government Printing Office.) 1.10 dollars.

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

A Campaign against Consumption. By Dr. A. Ransome. Pp. viii+263. (Cambridge: At the University Press.) 10*s*. 6*d*. net.

DIARY OF SOCIETIES.

FRIDAY, April 9.

Royal Astronomical Society, at 5.—(1) A Correction to the Determination of the Constants of the Node, the Inclination, the Earth's Ellipticity and the Obliquity of the Ecliptic; (2) The Elements of the Moon's Orbit: E. W. Brown.—The Errors of Measurements on Astrophotographic Plates: Winifred Gibson.—The Rotation of the Earth: Hermann Glauert.—A Simple Geometrical Construction for Determining the Heliographic Co-ordinates of Sun-spots: F. Henrotean.—*Probable Papers*: Comparison of Magnitude Scales. Sixth Note—The Oxford Magnitudes. With a Preliminary Discussion of the Existence of Obscured Patches in the Sky: H. H. Turner.—The Sun-spot and the Solar Corona of 1914, August 21: A. L. Cortie.

Alchemical Society, at 7.30.—The Phallic Element in Alchemical Doctrine: H. Stanley Redgrove.

MONDAY, April 12.

Aristotelian Society, at 8.—Phenominalism: C. D. Broad.

Victoria Institute, at 4.30.—Astronomical Allusions in Sacred Books of the East: Mrs. Walter Maunder.

Society of Chemical Industry, at 8.—The Detection of small quantities of Paraffin Wax in Beeswax, and the Determination of a new constant for East Indian and European Beeswaxes: M. S. Salamon and W. A. Seaber.—The Action of Dilute Acid, Alkalies and Salts on certain Metals: A. J. Hale and H. S. Foster.—Method of Assaying Copper: Arthur Fraser.—Resumed discussion of Dr. Tripp's Paper on "Dickson Centrifuge System of Sewage Disposal."

TUESDAY, April 13.

Society of Engineers, at 7.30.—Main Roads, Past and Present, and Modern Methods of Construction and Maintenance: F. Grove.

Zoological Society, at 5.30.—A List of the Snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola: G. A. Boulenger.—(1) Some new Carnivorous Therapsids in the Collection of the British Museum: (2) The Organ of Jacobson and its relations in the "Insectivora": Dr. R. Broom.—A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia: Dr. G. E. Nicholls.—Some Notes on the Nato Breed of Cattle (*Bos taurus*): E. Gibson.

Institution of Civil Engineers, at 8.—Impact Coefficients for Railway Girders: C. W. Anderson.

WEDNESDAY, April 14.

Geological Society, at 8.—Further Observations on the Late Glacial or Ponders End Stage of the Lea Valley: S. Hazzledine Warren.

THURSDAY, April 15.

Institution of Electrical Engineers, at 8.—The Power Supply of the Central Mining-Rand Mines Group: J. H Rider.

Institution of Mining and Metallurgy, at 8.

Linnean Society, at 5.—Experiments and Observations bearing on the Interpretation of Form and Coloration in Plants and Animals: C. F. M. Swynnerton.

FRIDAY, April 16.

Institution of Mechanical Engineers, at 8.—President's address Dr. W. Cawthorne Unwin.

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THURSDAY, APRIL 15, 1915.

COLOUR VISION.

An Introduction to the Study of Colour Vision. By Dr. J. H. Parsons. Pp. viii + 308. (Cambridge: At the University Press, 1915.) Price 12*s.* 6*d.* net.

THE whole subject of colour vision is admittedly very difficult, as the knowledge of it involves familiarity with the experimental results of a physical as well as of a physiological laboratory, with the minute anatomy of the retina, and with the latest results of psychological research. Hitherto, all that is known, and the various suppositions that have been made about the subject, could only be learnt by a prolonged search through innumerable scattered papers on physics, physiology, medicine, and psychology in various languages, chiefly English and German; so that it is with most cordial thanks to the author that this *résumé* of the subject in its present state is welcomed.

The book is divided into three parts: part i. (pp. 1–157) devoted to "The Chief Facts of Normal Colour Vision"; part ii. (pp. 158–192), "The Chief Facts of Colour Blindness"; and part iii. "The Chief Theories of Colour Vision." The arrangement is admirable, the facts are well described with very few omissions, and no one after reading the first 191 pages will be surprised that so far no theory has been suggested that will account for all the facts. Perhaps a few of the difficulties of the subject may be indicated.

A given colour may be determined as is well known by its hue, its luminosity, and by its degree of saturation. It is not always remembered that:—

"Great increase of intensity of light not only alters its hue, but also alters its saturation, so that eventually it produces only the sensation of white light. It would seem, therefore, that luminosity is in some recondite sense an inherent 'whiteness' in the colour itself, differing in degrees in different spectral colours and varying with the intensity of these colours. Clearly we are here at the outset face to face with a *physiological* fact of immense importance, and much of the difficulty of colour vision is connected with this fact" (p. 29).

There is the obvious difficulty in comparing the luminosity of two different coloured lights, arising from the fact that they give rise to two different impressions, and we are surprised to find that, according to the note in the preface, there is no discrepancy when the luminosity is measured by the equality of brightness method or by the flicker photometer. The curious coloured phenomena of rapid, intermittent stimulation of the retina (*e.g.* Benham's top) lead us to expect that there would be a marked discrepancy. However, the author's statements are fully borne out by Ives's results with the flicker photometer.

On p. 3 a sentence that refers to the diffraction spectrum has missed correction when the proofs were read:—

"It suffers, however, from the disadvantage that the spectrum is less bright and less extended than the prismatic spectrum, and from the still greater objection that the interference spectrum is never free from scattered light."

Surely the extent of the spectrum depends entirely upon the fineness of the grating, and its brightness may be increased by increasing the size of the grating; and if by the term "interference spectrum" is meant a diffraction spectrum, any impurity in it is due to the faultiness of the grating.

We are glad to notice Mr. Parsons's criticism of v. Helmholtz's spectro-photometer and similar instruments in which the intensity of light is reduced by means of Nicol prisms; much of the German work on the subject is inaccurate owing to the polarising methods used.

With regard to Weber's law, the important point mentioned on p. 20 that "it does not hold good for very low or very high intensities of stimuli" is to be borne in mind. Fechner's law is true within the limits that Weber's law holds. Schirmer found that it was true between 1 and 1000 candle-power illuminations (*i.e.* the function is continuous between these limits), but that at first his minimum difference was $\frac{1}{128}$, while after eight days' practice he could recognise a change of $\frac{1}{217}$ or even less (see *Ophth. Rev.*, vol. x., p. 179). Possibly the failure of the law at the lower limit might be explained by Fechner's later addition of a term s_0 to represent the "intrinsic light of the retina." If E denote the sensation, and S the stimulus, Fechner's law then takes the form

$$E = C \log(S + s_0) + C'$$

where C and C′ are constants. Mr. Parsons makes no reference to this suggested emendation. The failure of the law at the upper limit may be due to changes in the mechanism verging on the pathological. The variation of the minimum distinguishable difference not only in each individual, but also according to his practice (as in the case of Schirmer), necessitates great precautions being used in the application of Fechner's law.

When the eye has been kept in the dark for

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twenty minutes or so, the condition of scotopia or twilight vision is developed, in which the retinal sensibility is enormously increased; it will now be found that if the illumination be very low the eye is absolutely colour blind. The curve of luminosity in such an achromatic scotopic eye is practically identical with the luminosity curve of the spectrum in any colour-blind person (p. 53), the brightest part of the spectrum being near the E line (530 $\mu\mu$) instead of near the D line (580 $\mu\mu$) as in the normal eye.

The phenomena of simultaneous and successive contrast and fatigue are dealt with in pp. 100–129, and then there follows an interesting account of the researches on the discrimination of colour by various animals and by primitive races. Conclusions about both of these must necessarily be indefinite. With regard to the latter, the mural decorations of ancient Egypt show that the sense of colour for red, yellow, green, and blue was well developed five or six thousand years ago.

Limits of space forbid a review of Part iii. on the various theories of colour vision: the duplicity theory—that the cones are the seat of impulses that lead to colour perception, while the rods are only influenced by light stimuli; the three components theory (Young, Helmholtz); the three opponents theory (Hering); and seven other theories are described and criticised with justice and judgment. The author is to be congratulated on producing a work that contains an immense amount of information with a good bibliography on the subject. He has given us an excellent general and unbiassed view of the facts and theories of colour vision.

THE EXPERIMENTAL METHOD IN MEDICINE AND SURGERY.

Animal Experimentation and Medical Progress. By Prof. W. W. Keen. With an introduction by Dr. Charles W. Eliot. Pp. xxvi+312. (Boston and New York: Houghton Mifflin Company, 1914.) Price 7*s.* 6*d.* net.

IN America there are very few surgeons more eminent, more beneficent, or more widely beloved than Prof. Keen. He fulfils and represents the very highest traditions of American surgery. He has done great things in practice, and in teaching, and in writing; and his name is held in reverence by doctors and surgeons over here. So, when he writes a book for general reading on a medical subject, the general reader had better read it: especially as it has an introduction from Dr. Charles W. Eliot, sometime president of Harvard University. Besides, the book is admirably written, full of learning, full of sympathy, full of a thousand facts touching man's daily welfare.

It is a justification, and more than justification, of experiments on animals for the advancement of the science and art of medicine and surgery. Prof. Keen is one of those leaders of his profession who are very sensitive to the brutal abuse and false witness of the "anti-vivisectionists." Whether it is wise to care so much what they say, each man must settle for himself. Anyhow, Prof. Keen does care very much indeed. He takes it to heart that these wild people are set to insult the medical profession, to give the lie to plain facts, and to attack with virulent language the very methods which they themselves take advantage of when they are ill. These people seem to be just as unkind and untruthful in America as they are here. Indeed, we are having a rest from them here, since the war began; except that some of them are trying to stop our soldiers from being protected against typhoid fever. It will be a grand thing, after the war, if we can keep anti-vivisection down, and give ourselves to worthier pursuits.

The book is a collection of essays, from 1885 to 1913, on the debt which mankind and the animal world owe to experiments on animals; and on the character and the attitude of anti-vivisection. The essays are complete, final, authoritative; they are the work of a master of surgery, a leader among surgeons. Where all are good it is hard to prefer one before another. Among those essays which review the benefits gained from experiments on animals, nothing could be better than "Recent Progress in Surgery," "Vivisection and Brain-Surgery," and "What Vivisection has done for Humanity." Among those essays which review the moral obliquity of anti-vivisection, nothing could be better than "The Influence of Anti-vivisection on Character," and "The Anti-vivisection Exhibition in Philadelphia in 1914." These two essays are masterpieces; they are gentle, quiet, courteous; but they expose a state of mind, in some American women, which is not pleasant to contemplate. Things were bad enough here, up to last August; but they seem even worse in New York.

Indeed, that is one of the strongest arguments against anti-vivisection—that it tends, unless it be held under self-control, to such amazing dishonesty, such greedy willingness to believe evil of other men, such loss of the sense of responsibility and of restraint.

But these faults, after all, are not the main theme of the book: and the work of nailing lies to counters is less important to us than the work of setting forth the great discoveries of medical and surgical science and art, especially those discoveries which have been made within the last half-century. These chapters of history are as good as good can be, and here is a book full of good reading, written by one of the chief of living surgeons.

Stephen Paget.

PURE MATHEMATICS.

(1) *A Treatise on the Analytic Geometry of Three Dimensions.* Fifth Edition. Vol. xi. By Dr. G. Salmon. Pp. xvi+334. (London: Longmans, Green and Co., 1915.) Price 7*s.* 6*d.* net.

(2) *A Course of Pure Mathematics.* By G. H. Hardy. Second Edition. Pp. xii+442. (Cambridge: At the University Press, 1914.) Price 12*s.* net.

(3) *Proceedings of the London Mathematical Society.* Second Series. Volume xiii. Pp. liii+500. (London: Francis Hodgson, 1914.) Price 25*s.*

(1) It cannot have been an easy task to prepare the new edition of Salmon's classical treatise; the result may be considered quite satisfactory, although, no doubt, different readers will form different opinions about the choice of additions that has been made. In this volume, the principal ones are as follows:—First of all, a considerable addition has been made to the section on line-geometry. So far as we can judge, this has been very well done; it includes Ribaucour's theory of isotropic congruences, a good deal about normal congruences, and other interesting matter. Next, and partly connected with the foregoing, we have an account of curvilinear co-ordinates, triply orthogonal systems, and cyclides; also other theorems due to Ribaucour.

In the part dealing with cubic and quartic surfaces, there is a sketch of Segre's analysis of the singularities of cubics; Geiser's correspondence of lines on a cubic with bitangents of a plane quartic; and some very good articles on cyclides, and the special quartics of Steiner and Kummer. Towards the end of the book, we have eight pages or so on birational transformations, with some useful references, and a revised table of singularities, mainly based on Zeuthen's memoir of 1876 (*Math. Ann.*, x.). This last does not seem to be quite up to date; for instance, no reference has been made to the work of Enriques and Castelnuovo, and their discussion of the deficiency of a surface, which has yielded a new fundamental characteristic, besides that called the deficiency in this book.

Reference is made (Art. 527*a*) to some recent work on the reduction of a cubic to the canonical form $\sum_{1}^{5} x_i = 0$, and the proof that this is unique. One way of doing this is to obtain the equation $\Pi x_i = 0$, by a combination of invariants and covariants; this the present writer succeeded in doing a good while ago, with the help of Salmon's list of invariants, but the result was unpleasantly long.

Perhaps the most striking omission in the revised work is that of the theory of minimal surfaces. It would not have taken very many pages to give a fair account of this elegant theory, now that Lie and Weierstrass have reduced it to its simplest form. However, it may fairly be said that a student who has this work, and Prof. Forsyth's "Differential Geometry," will be able to make acquaintance with all the most important divisions of the subject, and be able to follow up any one in which he is specially interested.

(2) It is gratifying to see that Mr. Hardy's excellent treatise has so soon reached a second edition; and it helps to justify the statement in the preface that "it is no longer necessary to apologise for treating mathematical analysis as a serious subject worthy of study for its own sake." The author combines, in a remarkable way, strictness of method with an agreeable style; and his choice of topics seem to us to be eminently judicious. The principal additions in this re-issue are an account of Dedekind's theory of irrational numbers; a proof of Weierstrass's theorem about points of condensation, of the Heine-Borel theorem, and of Heine's theorem about uniform convergence; the notions of "limits of indetermination" and "implicit function" are also discussed. To save space, some analytical geometry and trigonometry has been deleted. The examples are well chosen, and hints towards solution are frequently given. This book, and Mr. Bromwich's "Infinite Series," to which Mr. Hardy refers in his preface, ought to do a great deal towards making school and college mathematics more rigorous, without making it repulsive; on the contrary, the apparent paradoxes explained, and the latent fallacies exposed, ought to provide a certain amount of fun, even for an undergraduate.

There are one or two very trifling points that may be noticed. On page 231, $D^{-1}(x^{-1})$, when x is negative, is defined as $\log(-x)$. This is very artificial, especially as the figure, page 359, implies that $\log x$ is undefined when x is negative. The same complaint of artificiality applies to the treatment of differentials (page 280). A rather more important point is on the proof (page 313) that the sum of a series of positive terms is the same "in whatever order the terms are taken."

This certainly requires more explanation than is given. The words "of course no terms must be omitted" begs the whole question; the sum is a *limit*, and we cannot take all the terms. Perhaps the following might be suggested. Let $\sum_1^\infty u_m$ be convergent as it stands, so that $\mathrm{Lt}(m\rightarrow\infty)u_m = 0$. Let $\sum_1^\infty v_n$ be so related to Σu_m that there is a one-one correspondence of terms, so that we can write

$$u_m = v_{m'}, \quad v_n = u_{n'},$$

where m', n' are determined by m, n respectively. Suppose *further* that when $m\rightarrow\infty$, then $m'\rightarrow\infty$, and that when $n\rightarrow\infty$, then $n'\rightarrow\infty$; in these circumstances we can infer that $\Sigma u_m = \Sigma v_n$. So far as Mr. Hardy's proof goes, we might infer that—

$$u_1 + u_2 + u_4 + \ . \ . \ . \ = u_2 + u_3 + u_4 + \ . \ . \ .$$

but this is not true, unless u_1 occurs at a finite place on the right.

(3) The contents of the last volume of the London Mathematical Society's proceedings are, as usual, very varied, and only a very gifted or very conceited reviewer would venture to express an opinion on the absolute or relative value of the different papers. As specimens, we note Mr. Bromwich's on Foucault's pendulum, Mr. Burnside's on prime-power groups, Mr. Carslaw's on Green's function for $\Delta^2 u + k^2 u = 0$, Mr. Hobson's on the linear integral equation, and Sir J. Larmor's on the electromagnetic force on a moving charge. There is also an interesting paper by Mr. Mordell on the diophantine equation $y^2 - k = x^3$. Altogether, the volume gives an encouraging view of the state of English mathematics, except for the lack of geometry, especially pure geometry. This is becoming really a serious symptom; not only is there an element of culture in geometry which analysis does not possess, but there is a risk of our studying the whole science from a one-sided point of view, even if (as is probable) strict mathematical geometry is reduced to formal logic applied to a few indefinable axioms.

G. B. M.

PSYCHOLOGY AND PHILOSOPHY.

(1) *The Foundations of Character, Being a Study of the Tendencies of the Emotions and Sentiments.* By A. F. Shand. Pp. xxxi+532. (London: Macmillan and Co., Ltd., 1914) Price 12s. net.

(2) *Perception, Physics, and Reality: An Enquiry into the Information that Physical Science can Supply about the Real.* By C. D. Broad. Pp. xii+388. (Cambridge: At the University Press, 1914.) Price 10s. net.

(3) *Philosophy: What is it?* By Prof. F. B. Jevons. Pp. vii+135. (Cambridge: At the University Press, 1914.) Price 1s. 6d. net.

(4) *Know Your Own Mind. A Little Book of Practical Psychology.* By W. Glover. Pp. ix+204. (Cambridge: At the University Press, 1914.) Price 2s. net.

(1) PSYCHOLOGISTS have been slow to meet the popular demand for a science of character. Under the name ethology, it was planned by John Stuart Mill. But Mill failed to accomplish his plan. The 'laws of psychology,' upon which he proposed to base his new science, were, in his day, inadequate and unsuitable for the task. In Mr. Shand's eagerly awaited book the attempt has been renewed. Will the new attempt meet with a greater success?

Judged by Mr. Shand's criterion, it undoubtedly will. Mr. Shand no longer claims to deduce the laws of character from certain fundamental conceptions, initially established as true. He seeks rather to formulate provisional hypotheses, and to test them by their fruitfulness. His method is thus concrete and synthetic. It gives him the viewpoint of the novelist and dramatist, of the biographer and historian; and enables him to utilise their material. In place of Mill's 'laws of association' he propounds the 'principle of organisation': all mental activity tends to produce and sustain system; and, in sharp distinction from the school of Mill, and in common with others who have more recently approached his field, he seeks the springs of conduct on the instinctive and emotional side of man's original nature, rather than on its intellectual side.

In his conception of character the chief place is given to those lower systems called emotions, and those higher systems, which he has already taught us to call 'sentiments.' The influence of intelligence and will is somewhat briefly dismissed. He treats more fully the influence of temperament; and, most suggestively, that of temper.

The present volume deals in detail with each of the primary emotions. Together with fear, anger, wonder, and disgust, he includes repugnance, surprise, sorrow, and joy. Tenderness, self-assertion, and self-submission are omitted. His list thus differs a little from that suggested by Mr. McDougall. A yet deeper difference is revealed in his treatment of instinct. In Mr. McDougall's view, to each principal instinct there corresponds innately some one specific emotion. According to Mr. Shand, an emotion may include within its system several instincts, and the same instinct may be found organised in several different emotions. The difference is partly a question of fact, which future investigation may well set itself to solve; but it is partly a question of what we are to term instincts. Emotion itself is defined so as to include a cognitive and a conative attitude, as well as one of feeling. But the part played by the former aspects is not quite as clear in the book as it obviously is in Mr. Shand's own mind; this perhaps is due to a postponement of a full treatment of knowledge, intelligence, and will to the later volume dealing with the sentiments.

Perhaps the least convincing feature of the book is the source from which Mr. Shand has collected his facts. To observational and experimental data he makes scarcely any appeal. In support of his one hundred and forty-four provisional laws he goes almost entirely to literature. To illustrate the association of qualities in various character-types he turns to Balzac and La Bruyère rather than to the correlations of Heymans and Wiersma, or the records of the followers of Binet, Stern, and Freud. In the present stage of knowledge he is perhaps justified. Doubtless, field-workers will soon come forward to collect observations, make experiments, and apply statistics. And for preliminary conceptions, problems, and hypotheses they can go to no more inspiring source than Mr. Shand.

(2) Mr. Broad's book attempts to discover how much natural science can actually tell us about the nature of the real. But, unlike recent authors who have approached this question, he deals with physical science rather than with biological. His chief philosophical concerns are perception and causation. His problems are thus those of Mach or Lotze rather than those of Bergson or Driesch. And his point of view owes much to Mr. G. E. Moore and Mr. Bertrand Russell. His treatment, however, is none the less suggestive. And his book provides an excellent refutation of Kant's dictum that, in dealing with the traditional problems, philosophy is concerned only with certainty and not with probability.

(3) The minds of most English people (so Mr. H. G. Wells has declared) will only be reached, under present conditions, by thoughts that can be expressed in the meanest commonplace. In "Know Your Own Mind" and "Philosophy: What is it?" we have two deliberate endeavours to falsify this pessimistic prophecy. Mr. Glover and Prof. Jevons have set themselves to interest the average man in two of the most abstruse and technical branches of human knowledge—philosophy and psychology. Unfortunately, philosophers and psychologists themselves may be inclined to think that the point of view represented in both is not indeed commonplace, but perhaps a trifle old-fashioned.

Philosophy and science, materialism and idealism, scepticism and philosophy, personality and the whole—these are the time-honoured themes that Prof. Jevons discusses in a masterly but time-honoured manner. They were chosen for lectures delivered at the request of a branch of the Workers' Educational Association. In the debates that followed, the burning controversies of the day, and the actual contributions of contemporary philosophers, were doubtless freely discussed; and so, perhaps, it was best that the main impression left was the enduring character of the old enduring questions. Often and ably as these have already been treated in brief, cheap, popular manuals, Prof. Jevons's little book will rank among the best.

(4) Mr. Glover's volume belongs to the same pleasantly printed and pleasantly bound series. In his endeavour to be up-to-date, he tells us, he has tried to catch something of the 'cinema spirit.' His metaphors, his similes, and his allegories are both vivid and picturesque. But his matter is not quite as up-to-date as his style. He gives us a revised and racy epitome of the traditional Herbartian psychology. But the methods and marvels of the psychological laboratory he dismisses as of little practical utility and no popular interest. Nor does he give any reference which would help his reader to realise that the knowledge of our own minds, like most other knowledge, has been largely extended by careful observation and experiment. His main purpose, however—to present the subject-matter of psychology in a light which will be intelligible and interesting to the man in the street—this he has brilliantly fulfilled.

OUR BOOKSHELF.

The Next Generation: a Study in the Physiology of Inheritance. By F. G. Jewett. Pp. xi+235. (Boston and London: Ginn and Co., 1914.) Price 3s. 6d.

The author of this skilful little book is persuaded that the improvement of the human breed would be accelerated if people knew more biology. They perish for lack of knowledge. "Science says human beings will be safer when people know the facts, and are influenced by them. Teachers say 'Give us the facts, and we will pass them on to the boys and girls whom we teach.' Both man of science and teacher agree that the human race will be better able to escape certain kinds of peril if we let young people know what the perils are, and how to avoid them. Such is the purpose of this book."

The general facts of evolution, heredity, and development are stated with simplicity and vividness, and on this foundation the author bases her instruction in regard to the culture of adolescence, the use of alcohol, the raising of the standard of parental fitness, and similar problems. In a detached appendix the dangers of venereal diseases are frankly pointed out. The author's general position is that much is to be attained by greater cleanliness, increased control of the hours and conditions of labour, and improved environment for children, but that there must also be some way of preventing the decisively unfit from becoming parents. The book is competent and wise, but some of the statements seem to us to require safeguarding. The citations as to child labour "in the greatest canning factory" in America are so terrible that we hope there is some mistake. The date should have been given. The book is dedicated to "Boys and Girls, the Guardians of the Next Generation," but we hope we are right in understanding that it is meant only for the teacher's use.

Principles of Physical Geography. By G. C. Fry. Pp. x+151. (London: W. B. Clive, 1915.) Price 1s. 6d.

THIS little book contains that part of the author's text-book of geography which deals with physical geography, with some additions on such subjects as map drawing, climate, and the crust of the earth, as well as a new chapter on man and his work. It contains no definite instructions for practical exercises to be worked by the pupil, but the descriptive treatment will prove suitable for students preparing for the examinations mentioned in the author's preface.

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 Thermionic Current.

IF a carbon filament lamp is silvered inside, and a platinum wire through the side of the glass makes electric connection with the belt of silver, it is easy to experiment with the thermionic current, using a telephone receiver with one terminal to the platinum wire and the other to the water mains.

With an alternating current at 110 volts, a loud note is heard, depending on the frequency of alternation. With a direct current from a dynamo there is sufficient variation in the voltage to obtain a sound just audible at 100, loud at 110, very loud at 130, and it might be described as an uproar at 140 volts. It might be expected that the intensity would increase until the lamp burnt out. Nothing of the sort. At 142 volts the uproar is replaced by dead silence, which continues up to 165 volts, as high as the lamp would stand.

The explanation may be gathered from Langmuir's paper (*Physical Review*, December, 1913). The thermionic current does not increase with the temperature, according to Richardson's law, unless the vacuum is of a high order. With a moderate vacuum the volume charge between the filament and silver causes the thermionic current to remain at a value nearly constant, as the temperature is raised above a certain value. The thermionic current begins by obeying Richardson's law ($i=a\sqrt{T}e^{-\frac{b}{T}}$), and then later approximates to a steady value.

Thus at low voltages variations of voltage cause variations of temperature and consequent fluctuations of thermionic current, heard through the telephone.

Above 140 volts, however, for the particular lamp in question, a change of voltage and of temperature produces no change of current, and hence no sound can be heard in the telephone.

It is possible that this method may prove very convenient for testing the electron emission from various substances in different gases, and it suggests a method of measuring a high vacuum. A. S. EVE.

McGill University, Montreal, March 31.

A Mistaken Butterfly.

WHILE waiting for a car at Pacific Grove, Monterey County, California, on February 12 (Lincoln's birthday) of the present year, I noticed that a man standing near me had the brightly-coloured "eye" of a peacock's feather in the band at the back of his hat. While looking at this I saw a butterfly floating above the man's head. It suddenly lighted on the "eye" and apparently began trying to extract food from it. I directed the man's attention to it; he removed his hat, and we watched the insect for several minutes as it tried to secure food from the feather. It then flew away, as if satisfied that it had made a mistake. I do not know the name of the butterfly, but it was one of many of a light brown colour that seem to be plentiful at Pacific Grove at that season. I was told that these butterflies at a certain time regularly alight in thousands upon a special pine tree (one of a great many) in the western edge of the town, and from this fact they have called it the "Butterfly Tree." I do not know whether these insects seek their food from flowers by the sense of smell or that of sight, but it was evident in the present case that this one was guided entirely by sight.

E. E. BARNARD.

Yerkes Observatory, Wisconsin, U.S.A March 29.

BRITISH SUPPLY OF DRUGS AND FINE CHEMICALS.

AT a British Association meeting about twenty years ago an eminent physicist received some rough handling from his chemical colleagues on account of the impurities which were manifestly present in the materials he had used in his experiments. He replied, in effect, that chemists should employ themselves in purifying chemicals for physicists to use. Nowadays chemicals such as he would have desired are made by the ton, chiefly by three firms in Germany. For ordinary chemical, and even physical, research such fine materials are turned out that it may be doubted in many cases if the work done with them is worthy of such refinement. Frequently the chemicals used are better than the chemist who works with them could have produced for himself. For work of the highest degree of refinement, such as the determination of atomic weights, the chemicals which can be purchased cannot be used without much further purification, but even in these cases much time is saved by the previous elimination of the grosser forms of impurity. To those who were in their early days limited to chemicals produced in this country, the standard of purity attained by the German manufacturer came as a revelation, and the study of prices made it clear that the enormous advantage gained by the use of the German materials was obtained at no unreasonable cost. The standard set by the German makers has not even been aimed at by our own countrymen, and the words "pure," "puriss," and "absolutely pure, for examination purposes" on the labels, are ludicrously misused. Want of method, want of care, and the employment of workmen instead of chemists in the preparation are at the bottom of the failure.

With regard to drugs, it has been stated that some eight hundred different medicinal preparations have been patented within recent years by German chemists, and although this is probably an exaggeration, it is certain that a very large number of such substances have been prepared, and that many of them have been found of sufficient value from the physiological point of view to warrant their retention as commercial products.

In these days when the relationship between chemical constitution and physiological action is fairly well understood, it is clear that the discovery of an organic structure which has valuable physiological action will lead to the preparation of large numbers of others differing but slightly in composition, and that these will find their way into patent literature mainly in the hope of their being useful, and, incidentally, to retain the field for further investigation. Such was the case of salvarsan, and since the discovery of that substance by Ehrlich, the patent literature has teemed with specifications dealing with the preparation of organo-metallic derivatives of almost every conceivable description. The antipyretics, again, of which phenacetin and aspirin may be quoted as types, belong to definite groups of organic compounds, the other members of which possess more or less important properties, depending on a slight change of structure the nature of which is not definitely understood.

There is another class of drugs of which the Germans have made a special study, those which are obtained from vegetable sources. In looking through their descriptive catalogues (in English) which are largely circulated among medical men in this country, one is struck by their far-reaching enterprise in this direction. Their travellers have gone to the ends of the earth to investigate native diseases and the local remedies which are used for their treatment. So long ago as 1850, Schweinfurth, in his journeys in central Africa, compiled a list of such remedies and brought home specimens of plants from which they were made. In Germany a large trade is now done in the extracts from vegetable sources collected from the remotest corners of the globe, many of them British possessions. The medicines are sold in elegant and even attractive form, and those whose memories go back to the pre-tabloid days may well envy the younger generation. It would not be just to underestimate the work done by certain firms in this country in the same direction, but in the number of the drugs and the enterprise shown in collecting new ones, we are, without doubt, behind our enemies.

In these matters of fine chemicals and drugs, both synthetic and natural, it is an arguable question whether the trade should be left as it is. On one hand it might be said that the work is admirably done by the German manufacturers in both branches; they have large and capable staffs and works excellently fitted for the purposes for which they were built; should not these particular manufactures be left in their hands? On the other hand, we have a sense of humiliation that we should be, in any conceivable juncture, dependent on those who are at present our enemies. Certain allied manufactures, *e.g.*, heavy chemicals, are still left largely in our hands, but if we yield in the smaller trades, is it not likely that they will succeed in wresting from us the larger source of profit? There can be no convention or agreement in these matters; each country will make what profit it can in the most convenient direction. "Capturing the Enemy's Trade" makes a good newspaper heading, but it is painful to read the many impracticable suggestions which have been made on the subject since the beginning of the war. Many people seem to have the idea that all that is wanted is that a works shall be built, or even a derelict factory be adapted, and then the thing is done. No thought is given to the years of patient research, the long training of the workers, and the period which must elapse before even the raw materials could be collected.

In the particular directions with which this article is concerned there is no doubt that the thing can be accomplished in time. In one laboratory of university rank the manufacture of three synthetic drugs in large quantities has been carried on since the opening of the war, and the resulting products have been handed over to the naval hospitals which were in urgent need of them. The preliminary investigation in this piece of work occupied a staff of seven experienced workers, under the direction of the professor, two whole months before the details of the processes could be mastered. The results not only gave to the naval service what was wanted at the moment, but they enabled the details of the processes to be handed over, through a committee of the Royal Society, to three manufacturers who will produce the drugs on a large scale. In a similar way the laboratory of another institution has succeeded in working out the process of making a natural drug from its plant sources. These instances illustrate the magnitude of the task which is before us, and the amount of highly specialised labour which must be employed on the problems. It is only courting failure if the conditions necessary are not realised before a start is made.

In the matter of highly purified chemicals another point must be noticed. The reputation of the German makers is high, and deservedly so, and it follows that it will be a long time before possible rivals, even if they produced materials of an equal degree of purity, could obtain the same degree of confidence in the minds of their customers. In order to give this confidence it has been suggested that the object might be most quickly attained by the establishment of a National Chemical Laboratory analogous in constitution and management to the National Physical Laboratory, in which the products of the manufacturers could be tested and the standard of purity guaranteed. The scheme would undoubtedly serve to hasten matters. The guarantee of the National Physical Laboratory is accepted as impartial and accurate throughout the world, and there is no reason why a chemical institution of the same kind should not command equal confidence. Into the question of cost there is perhaps no need to enter, but the fact must be faced that the average man would not expect to pay a much higher price than he has paid heretofore because the substances were made in England. H. B. Baker.

HOME FORESTRY AND THE WAR.

In an article in Nature of December 10, 1914, p. 393, it was shown how dependent we were upon foreign countries for our supplies of pitwood, without which coal-mining could not be carried on. About half the total amount of pitwood exported in normal times into the United Kingdom comes from Baltic ports; and as a result of the action of Germany in declaring pitwood contraband, the supplies from this source have practically ceased, what now arrives from Scandinavia being merely small cargoes from Gottenburg, Christiania, and other ports outside the Baltic. The important supply of pitwood from France, Spain, and Portugal still continues, though at enhanced prices; and in case of need, large quantities can be obtained from Nova Scotia, Newfoundland, etc. Nevertheless, it became necessary to ascertain the available amount of home-grown timber suitable for use in mining; and an inquiry into the subject was undertaken by the forestry branch of the Board of Agriculture, the report of which has been issued with great promptitude. From this it appears that the total area of woodlands in England, 1,884,000 acres, is capable of yielding 380,000 tons of pitwood annually by normal fellings; and that by anticipating the fellings of the next five years almost 3,400,000 tons of pitwood are available in England and Wales alone. Scotland by similar extraordinary fellings could supply about 2,500,000 tons; so that with the aid of a small quantity from Ireland, about 6,000,000 tons of pitwood could be felled, enough to keep the collieries going for eighteen months, as their average annual consumption of pitwood is approximately 4,500,000 tons.

In the *Quarterly Journal of Forestry*, January, 1915, pp. 1–7, Sir W. Schlich, criticising the preceding report, asks what will be the position if the war should last for more than two years; and considers that in this case our coal mines would be obliged to shut down for want of pitwood. As labour in Canada is very expensive, he believes that supplies of mining timber from Nova Scotia, etc., may prove unavailable on account of the prohibitive cost. He urges upon the Government the necessity of taking early steps to increase the area under trees in these islands, and reiterates well-known arguments that, however sound, appear to have little effect upon our rulers. He sums up as follows:—

> Forest schools have been set up for instruction in forestry; a forestry branch has been established in connection with the Board of Agriculture and another in Ireland; an officer has been appointed to convert the Dean and High Meadow Woods into a demonstration area. All this is in the right direction, but *very little has as yet been done to increase the area under forest.* Too much talking and too little action —that is the long and short of it. Let us hope that the new situation will lead without further loss of time to action. Of course, I should not advocate the taking of a single acre out of cultivation, because the production of food goes before everything else; but there are large stretches of land unfit for cultivation and yet quite fit to produce forest crops. Nor should I advocate the formation of large blocks of woodland, all in a ring fence as it were. No, what I look forward to are moderate sized areas scattered over the country. As long as the area is sufficiently large to justify placing a woodman in charge and also sufficient to be placed under systematic management, say a minimum of 500 acres, we snall have all that is required. In that case agricultural labourers and tenants of small areas will in time come forward and do the bulk of the forest work during the winter months, when agricultural work is practically at a standstill, thus improving their resources. Such a scheme will not be perfection all at once, but it will come by degrees. Only let the Government, with funds allotted by the Development Commissioners, start actual work, even on a small scale; it is sure to grow.

Another article in this journal deals also with the subject of pit-timber, and reviews the result of an independent inquiry by the English Forestry Association. Further articles treat of the preparation of yield tables, which are necessary in the estimation of the financial returns that are probable, when waste lands are afforested. Mr. Hiley writes a preliminary report on an investigation at Oxford into larch canker, and advocates a means of treatment which is scarcely advisable on account of the expense, not to mention the fact that the mode of infection on which the treatment is based is not yet clearly demonstrated to be the actual one.

In the *Transactions of the Royal Scottish Arboricultural Society*, xxix., part i. (January, 1915), the production of pitwood on wooded estates in Scotland is investigated by Mr. J. H. Milne Home, both as regards the present crisis and also with a view to a permanent increase in the supplies of mining timber in the future. Mr. Home considers that one-fourth of the normal amount required by British collieries could be readily supplied from Scotland, if railway rates of freight could be reduced by 25 per cent. An admirably illustrated paper by Mr. P. Leslie deals with the afforestation of the coastal sand dunes at Culbin, between the rivers Nairn and Findhorn. The Culbin sands have a remarkable history, as they conceal an estate of 3600 acres, which was once the richest agricultural district in Morayshire. The incursion of the sand took place suddenly in 1694, leaving a wilderness until 1865, when Major Chadwick began plantations, which have been continued by his son. The species mainly used has been been Scots pine, but Corsican pine wherever planted has given the best results, producing tall, clean poles of valuable timber. The operations, which include the prior fixing of the moving sands (Fig. 1) by maram grass, are carefully described, and are similar to those used by the French in the Landes.

Photo] [*Geological Survey.*

Fig. 1.—Culbin Sand-hills, Elginshire: near the Binsness Plantations. The background shows a travelling dune of advancing sand. The steep bank with cornice atop and slipping sand on slope, the tails of sand behind the tufts of bent, and the wind ripples in the foreground, indicate that the sand-drift is from left to right, *i.e.*, from west to east.

Wood-charcoal and its uses is the subject of an article by Mr. W. D. Ashton Bost, who states that the only firm in Britain which reduces iron-ore by charcoal is that of Messrs. Harrison Ainslie. Their charcoal furnace at Backbarrow on the river Leven in Cumberland produces annually about 2400 tons of so-called "Lorn" charcoal pig-iron, which is the dearest iron in the market, and is exported for special uses to all parts of the world.

The production of potash salts from woodlands and wastelands is the subject of a timely article by Mr. G. P. Gordon. It is probable that the material obtained by burning lop-and-top and brushwood in plantations and bracken fern on wild hill-sides, together with the ash of furnaces, using sawdust as a fuel, can compete successfully with kainit, which has been for many years the main source of the potash salts that enter into the composition of artificial manures. There is an account of a peculiar witches'-broom infesting willow trees at Hampstead and in parts of Essex near London, which appears to be hitherto undescribed. Prof. A. Henry gives an account, from Japanese sources, of the distribution of *Larix leptolepis* in its native home.

Many useful notes from continental sources are given, of which the following may be cited, taken from the Norwegian *Manual of Silviculture* by Barth:—The limit of the existence of forest trees in Norway is fixed by the mean temperature of the four months of vegetation, June to September. Birch is content with a mean summer temperature of 45° F.; aspen and grey alder with one just under 46° F.; Scots pine and spruce, 47° F.; *Alnus glutinosa*, 54° F.; oak, 55° F.; and beech, 56° F. It would be interesting to obtain similar figures regarding the limit of these species and larch in Britain.

THE CARNEGIE TRUST.[1]

THE Carnegie Trust for the Universities of Scotland has steadily pursued the policy of making quinquennial distributions of the funds at its disposal; and the present year finds the third of these schemes in operation. The total sum to be expended during the current five years was 203,250*l*. Of this, 21,250*l*. is to be applied towards providing books, etc., for the libraries of the universities; 160,750*l*. goes to supply new buildings and permanent equipment; while 21,250*l*. is to be spent on endowing lectureships and upon other general purposes.

With regard to that portion of the scheme which concerns itself with assisting students by paying their class fees, a sum of 41,789*l*. was paid on behalf of 3,900 beneficiaries in 1913–14. It is gratifying to note that in the same period 605*l*. has been repaid to the trustees by beneficiaries who had been assisted under the scheme.

The expenditure on research for the current twelve months is divided as usual under the heads of scholarships, fellowships, and grants, with the additional expenditure necessary to support the laboratory of the Royal College of Physicians in Edinburgh. 1392*l*. has been spent upon the laboratory, while the fellowships, etc., have necessitated an outlay of 7652*l*.

These sums have not been expended without good return, as the present report shows. Special mention is made of the long and conspicuously successful investigations of Dr. Margaret B. Moir on the effect of temperature upon the magnetic properties of steel; while the executive committee point to the work of Dr. Dougall on elasticity as a proof that their fellows do not relinquish research with the termination of their fellowships, but continue to bring forward investigations of first-class importance.

The scholars in the branches of chemistry and physics have published no fewer than thirteen papers during the session, and much unpublished work is still in process of completion. The research grants have aided in the production of twelve papers during the present year; and in this connection stress is laid upon the collaboration between the permanent staffs of the universities and other beneficiaries of the trust, the cases of Profs. G. G. Henderson, J. C. Irvine, and Dr. T. S. Patterson being singled out as examples of success in this respect.

In more than one direction, the war has had an effect upon the progress of the research scheme. Naturally, as far as materials go, the chemical field is the one most affected, owing to the difficulty of obtaining substances for some classes of work; but all branches have suffered owing to the enlistment of fellows and scholars in the army. No fewer than nine of the fellows and scholars have interrupted their scientific careers for this object; and it is satisfactory to learn that their positions are being kept open for them should they wish to resume research work after the war. A similar state of affairs is found in the Royal College of Physicians' laboratory, from which no fewer than nine of the workers are absent on military duty; so that this institution has been heavily handicapped during the current year.

Bearing these factors in mind, the results obtained in the operation of the trustees' scheme during the period covered by the report cannot be said to fall below the high standard attained in previous years; and it must also be recalled that many of the beneficiaries of the trust have resigned their fellowships or scholarships in order to take up permanent positions either in the universities or in other lines of professional work.

During the academic year 1914–15, twenty fellows and forty-seven scholars have been at work, while grants have been given to seventy-eight applicants. The investigations of these beneficiaries are extended over so wide a field of knowledge that it is impossible even to mention the branches of science, medicine, history, and languages in which work is being carried out; but a perusal of the report leaves the impression that the operations of the trust are steadily opening out wider and wider fields. The success of the trust's methods has never been in doubt, and the interest of observers becomes concentrated upon the developments which seem likely to flow from this vast machinery for enabling competent investigators to acquire a grasp of the methods of research, and to put the knowledge thus obtained into practice on a bigger scale than would otherwise be possible to them.

[1] Thirteenth Annual Report of the Carnegie Trust for the Universities of Scotland, 1913–14.

INEXACT ANALOGIES IN BIOLOGY.[1]

THE philosopher of the forum is notorious for the looseness of his analogical arguments from biology, and biologists themselves deserve castigation for their lax terminology. Even a Galton can write: "Parents are very indirectly and only partially related to their own children." Every word has its halo, and may be regarded according to one's point of view as either a potted poem or a tabloid theory. When the theory has been overturned, the use of the word in serious argument is dangerous. Then comes the critic to set us straight again, and so here is Dr. Johannsen putting such blessed words as "evolution," "affinity," "tradition," and "inheritance" in their proper places. So far as he condemns the use of inexact analogy, especially as a method of proof, we shall all agree with him—at least theoretically. But an analogy, strict in its application, may be falsified by its premisses. Many such are rejected by Dr. Johannsen as incorrect presentations of the facts of organic life and history. But here he often seems a little too certain that his interpretation of nature is the only right one. Belonging to the strictest sect of the Mendelians, he believes that, though the organism may respond variously to external

[1] Falske Analogier med Henblik paa Lighed, Slaegtskab, Arv, Tradition og Udvikling. By W. Johannsen. 8vo, pp. 114. (København, 1914).

conditions, the constitution of the germ is unaffected thereby, and that any change in it is necessarily discontinuous. Hence, though individual growth is inevitably continuous, organic evolution must be discontinuous; and any analogy between race-history and individual history must be false. The idea that the latter recapitulates the former "cannot be applied to concrete instances."

That likeness does not necessarily imply relationship is true enough; but there is more than "likeness" when we find the last of an ascending series of fossils repeating in its life-history the adult stages of the successive species immediately preceding it, all those stages having been linked by gentle gradations. The semblance of continuous evolution may conceivably be explained by an appeal to the mongrel (heterozygote) constitution of the germ, and by allowing wide limits of modification to the soma, in successive species. But why is the trend of germinal saltation so often the same as that of somatic modification, and why should individual growth repeat and follow this trend? These are questions not of analogy, but of fact, and are not to be dismissed with a bare denial.

Biologists may differ on these matters, but all might read with pleasure Dr. Johannsen's criticism of Prof. Bergson's "Élan vital."

F. A. Bather.

PROF. OTTO N. WITT.

By the sudden death, through heart-failure, on March 23, of Otto Nikolaus Witt, Geheimer Regierungsrat and professor in the Technical High School of Charlottenburg, at the comparatively early age of sixty-three, and in the full maturity of his intellectual power, Germany loses one of the most distinguished of her teachers of chemical technology, and one of the most successful of her pioneers in the application of organic chemistry to industrial pursuits. Of Russian extraction, Witt had intimate associations with all the countries now warring against Germany. Like Hofmann, Griess, Caro, Martius, and others who could be named—the founders of Germany's unrivalled supremacy in the manufacture of the so-called coal-tar dyes—upwards of thirty years ago Witt spent some time in England as a member of the now defunct firm of Williams, Thomas and Dyer, then engaged in the industrial production of this class of colouring matters. He took kindly to English life, moved freely in scientific and literary circles in London, joined the Savile Club, which had then its home in Savile Row, had his boat on the river, and enjoyed to the full the hospitality which his many social gifts, the range of his knowledge, his admirable conversational powers and charm of manner readily secured for him.

Witt spoke and wrote our language with ease and fluency. *Habitués* of the Royal Institution well remember the brilliant Friday evening discourse he gave on the development of the synthetic indigo industry, illustrated with a wealth of material and a mass of detail which his close connection with the great firms which have combined to exploit that industry had enabled him to accumulate. Among the many fruits of his scientific activity in England at that time may be mentioned his paper in collaboration with Thomas, on the induline group, published in the Transactions of the Chemical Society for 1883. At another period of his career he was associated with Nölting and Grandmougin, at Mulhouse, in developing the chemistry of the indazole derivatives, and his Alsatian connections brought him into contact with the leading manufacturers of synthetic colouring matters in France, and he learned to know Paris and to appreciate its scientific interests as fully as he knew and valued those of London.

The most fruitful period of Witt's scientific activity was comprised between the years 1876 and 1892. During the earlier years of his connection with the Charlottenburg institution, he was hampered by the want of adequate laboratory accommodation, and in spite of his acknowledged position as an authority on that particular section of applied organic chemistry with which his name and fame are indissolubly associated, and notwithstanding his generally recognised powers as a teacher, his success in creating a school fell short of his hopes, and neither the number of his students nor the character of their output, as determined by the quality and number of their communications to chemical literature, were commensurate with his aspirations.

Witt was one of the earliest to attempt to explain the properties and colour of dyes in terms of chemical constitution, and his memoir of 1876, published in the *Berichte* of the German Chemical Society, attracted considerable attention by the originality and boldness of its views, and the ingenuity with which they were supported. The terms "chromophor" and "chromogen" which he introduced in order to denote the special groups and molecules which he conceived to be concerned with the production of colour are still current in the literature. Although Witt's hypotheses have not wholly stood the test of time, the paper will always have its place in the history of the subject. It is at least noteworthy as the production of a young man of twenty-four.

Witt's name is associated with the discovery of certain typical classes of synthetic dye-stuffs. His published work includes papers on the indulines and indophenols; on the nitroso-derivatives of aromatic amines, eurhodines, eurhodols, safranines, etc., and he contributed the monographs on azines, indamines and indophenols, artificial indigo and indigoid dyestuffs, and triphenylmethane colouring matters to the "Dictionary of Applied Chemistry," published by Messrs. Longmans, Green and Co. They are amongst the most valuable articles in that work, and are characterised by Witt's excellent literary qualities, his grasp of principles, his power of co-ordination, his sense of proportion, and felicity of expression—qualities exhibited in no less degree in his frequent contributions to *Prometheus*, with which he was associated as editor for many years, a periodical which played much the same part in Germany as Nature does among English-speaking communities.

Witt was a singularly gifted man, of great attainments, artistic and literary, of large sympathies and wide interests, far removed indeed in mental habit and outlook from what is usually regarded as the typical German professor. He had an extensive knowledge of what is best in the literature of nearly every European nation, to which his remarkable linguistic attainments gave him ready access. In early life he was attracted to biological problems, was an excellent microscopist, and rivalled Cleve in studying and delineating the lower forms of organic life. In his later years he was devoted to the culture of orchids, and was an occasional visitor to the Temple show of our Royal Horticultural Society, and a frequent purchaser at the plant auctions in London. Of his power of initiative and capacity for organisation and direction, and of his merits as a host, those who attended the International Congress of Applied Chemistry at its meeting in Berlin, of which he was president, have a pleasurable and grateful recollection. T. E. Thorpe.

NOTES.

We regret to announce the death, on April 10, in his eightieth year, of Dr. W. Grylls Adams, F.R.S., Emeritus Professor of Natural Philosophy and Astronomy in King's College, London.

The death is announced, at nearly sixty-two years of age, of Dr. Louis Waldstein, author of "The Subconscious Self," and of many articles on pathological subjects.

On Monday, April 12, at a meeting of the Council of the Royal Society of Arts, the society's Albert Medal was presented to Senator Guglielmo Marconi "for his services in the development and practical application of wireless telegraphy." The medal, which was instituted in 1863 to commemorate the Prince Consort's presidency of the society, is awarded annually as a reward for "distinguished merit in promoting arts, manufactures, and commerce."

According to a message to the *Morning Post* from its Stockholm correspondent, the projected Anglo-Swedish Antarctic Expedition, under the leadership of Prof. Otto Nordenskjöld, has been postponed until the war has been brought to a conclusion. It will be remembered that the expedition was to sail in August next.

The death is announced of M. Edmond Rigaux, of Boulogne, in his seventy-seventh year. M. Rigaux was a well-known authority on the geology of the Boulonnais, and contributed especially to our knowledge of the Jurassic rocks and fossils of that region of France. He was a foreign correspondent of the Geological Society of London, and in 1883 received the Lyell Fund of the Society in recognition of the value of his researches.

The Jacksonian prize of the Royal College of Surgeons for 1914 has been awarded to Mr. Jonathan Hutchinson for his essay on the pathology, diagnosis, and treatment of trigeminal neuralgia, and the John Tomes prize to Mr. J. F. Colyer for his work on comparative dental anatomy and pathology. The subject of the Jacksonian prize for 1916 will be "Methods and Results of Transplantation of Bone in the Repair of Defects caused by Injury and Disease."

Protozoologists and marine biologists will be interested to learn that the whole of the collections and library of the late Fortescue W. Millett, of Marazion and Brixham, have been acquired by Mr. Heron-Allen, and will be incorporated as a special section of the Heron-Allen and Earland collection, to which the collection of the late J. D. Siddall, of Chester, was also added recently. It is hoped that this entire collection, numbering some 10,000 slides, and the library which accompanies them, will ultimately be incorporated with the Museum of Oceanography and Marine Biology, which it was the ambition of the late Sir John Murray to found. Broadly, his object was to form his collections of material and soundings into a department of the Natural History Museum in conjunction with the H. B. Brady and W. B. Carpenter collections, which are already there. The co-ordination of the Brady, Carpenter, Murray, Millett, Siddall, and Heron-Allen and Earland collections would form a reference museum of oceanic deposits and type specimens without an equal in the world.

The death is announced at the age of sixty-three of the well-known bacteriologist, Friedrich Loeffler, director of the Institute of Infectious Diseases, Berlin, and formerly Professor of Hygiene and Director of the Hygienic Institute, University of Greifswald. Loeffler's name is best known as the co-discoverer with Klebs of the diphtheria bacillus; this was in 1884. A year or two previously the presence of peculiar bacilli in the diphtheritic membrane was noted by Klebs, but it was Loeffler who afterwards isolated and cultivated this organism. With Koch and Gaffky, Loeffler carried out investigations on disinfection with steam at the Imperial Institute of Hygiene, Berlin, and he showed the keenest interest in the comparative study of the infectious diseases of animals, such as the diphtheria of calves and of pigeons. He was with Schütz the discoverer of the nature of the causative organism of foot-and-mouth disease, which he proved to belong to the group of micro-organisms known as "filter-passers," which owing to their minuteness are invisible with the highest powers of the microscope, and are capable of passing through the pores of a porcelain filter. To Loeffler also belongs the credit of achieving some of the early work associated with the application of aniline dyes to the staining of bacteria, "Loeffler's Methylene Blue" being used to this day as a routine laboratory stain. Loeffler's name will ever rank with those of Pasteur, Koch, and Ehrlich as a pioneer in the domain of bacteriological research.

The death of Major Samuel Flood-Page removes from the electrical world an interesting personality who played no small part in two important developments—electric lighting and wireless telegraphy. His first notable achievement after leaving the army was the organisation of the Electrical Exhibition at the Crystal Palace in 1882, when he was acting as manager of that institution. About this time the problem of the subdivision of the electric light had been solved by the introduction of the carbon incandescent lamp, and Major Flood-Page devoted his energies to promoting the commercial utilisation of the new illuminant. He was instrumental in introducing the first incandescent electric light into Australia, and then became secretary and manager of the Edison and Swan United Electric Light Co., Ltd. In the later years of his life he was interested in wireless telegraphy, and his faith in the ultimate success of this enterprise guided him through the many trials and difficulties which beset its path in the early days. Major Flood-Page first became actively engaged in wireless telegraphy in 1899, when he joined the Marconi Company in the capacity of managing director. In that year wireless telegraphy had advanced to a stage which permitted the establishment of communication across the Straits of Dover, between the Chalet d'Artois, Wimereux, near Boulogne, and the South Foreland lighthouse. He was one of a small party which waited at the wireless station at the Needles, Isle of Wight, in November, 1899, for the first wireless signals ever sent from a liner at sea to the British shores, and he was ever proud to recall the delight and satisfaction which he enjoyed as the liner's message was being received over a distance of sixty-five miles. After resigning the managing directorship, he remained a member of the board of the parent Marconi company and many of its leading subsidiaries. He died on April 7, in his eighty-second year.

Sir Rupert Clarke, who in the summer of last year led an expedition up the Fly River in British New Guinea, recently arrived in London to take up an appointment in the Army Service Corps. In 1890 Sir W. Macgregor reached a point 610 miles from the mouth of the river. Sir Rupert Clarke's expedition went 20 miles further. He also made the first ascent of Mount Donaldson, close to the German boundary. In a communication to the *Times* of April 10, he reports that the natives, a fine-looking, tall race, were at first inclined to be hostile, but later became friendly. They are divided into communes ranging in numbers from five or ten families to a thousand persons. No one is supposed to die a natural death, which is caused by suggestion through their magic men. After a man's death his relations must get a head so that his spirit may rest in peace. These heads are usually those of the women and children of hostile tribes. They are in constant fear of attack from their enemies, and live on scaffolds raised on high trees. Their bows are exceedingly formidable, beyond the strength of a white man to draw. They protect themselves from arrows by a kind of bamboo cuirass. They wear no other clothing. The height of Mount Donaldson was provisionally fixed at about 2000 ft. The return journey was effected in safety, without firing a shot, on rafts down the Fly River. Some signs of gold were discovered, but not rich enough to make working worth the trouble.

The Royal Geographical Society has received news of Sir Aurel Stein's explorations in Central Asia from April to November, 1914. The expedition started in April from Tunhuang, where it had halted to recruit after the trying campaign in the Lop-nor desert between Turfan and the northern boundary of Tibet. The cave temples of the Thousand Buddhas near Tunhuang were re-visited, and further interesting collections were made. The explorer followed the ancient wall for 250 miles, and found that it was constructed of fascines of reeds or brushwood, admirably adapted to check the wind erosion of the desert sands. Coins, pottery, and metal fragments found near the surface made it possible to define the Chinese frontier posts with accuracy. Beyond the So-lu Hu valley further remains of the same kind were found. While Sir Aurel Stein was hunting for remains of the Great Yuechi on Indo-Hun culture to the north, his surveyor, Lal Singh, examined the ruined town of Khara Khoto, and proved that this could be no other than Marco Polo's "City of Etzina," where in ancient times travellers bound for Karakoram, the old Mongol capital, used to lay in supplies for the march across the great desert. Here many Buddhist remains were found, and it was ascertained that the ruin of the city was due to failure to maintain the irrigation system. When he despatched his report Sir Aurel Stein had planned to examine Buddhist ruins round Turfan, while his surveyor was to undertake the exploration of the little-known desert ranges of the Kuruk-tagh between Turfan and the Lop-nor depressions.

A systematic paper on Termites from the East Indian Archipelago, by Masamitsu Oshima, has been published in *Annotationes Zoologicae Japonenses* (vol. viii., part 5). Of the twenty-four species enumerated, nineteen are described as new to science. The author imitates many modern American entomologists by illustrating his new species with photographic figures, most of which are valueless for the purpose of identification.

In the April number of the *Entomologists' Monthly Magazine* Mr. J. T. Wadsworth records the occurrence at Northenden, Cheshire, at the roots of cabbages, of the larvæ of an anthomyid fly (*Phaonia trimaculata*) new to the British fauna. Several of the grubs pupated, and eventually developed into the perfect insect, which measures 16 mm. across the extended wings—a fact rendering it somewhat remarkable that such a comparatively conspicuous species had not previously been observed in this country.

Many English-speaking naturalists who attended the meetings of the International Entomological Congress at Brussels and Oxford remember with pleasure conversations with a courteous and enthusiastic Spanish priest, the Rev. P. Longihos Navas, S.J., whose good knowledge of French made him a valuable interpreter to his compatriots. We have received a little "Manual del Entomologo," written by Father Navas, and published last year by the Catholic Press of Barcelona. It contains concise directions to the beginner for collecting, preserving, and classifying insects. Neither old nor new methods have been overlooked, for a well-worn figure of a collector "beating" into a venerable type of umbrella faces a sectional drawing of the modern "Berlese funnel."

Dr. Rolf Witting continues to contribute a great deal of most valuable hydrographical information on the sea-waters in the neighbourhood of Finland. In addition to the *Jahrbuch*, 1913, of the *Finländische Hydrographisch-Biologische Untersuchungen*, No. 13, which contains the details of salinity, temperature, and current measurements obtained on the seasonal cruises and at particular stations, we have received special papers by him on the optical and chemical examination of the water samples and on the methods of determining traces of ammonia in sea-water, as well as a paper by Prof. K. M Levander on the plankton of the Tavastfjärd. The oceanographers of Finland are to be congratulated on the regularity and persistence with which this work has been maintained for a number of years upon a uniform plan, a persistence which has obtained for them a place in the forefront of the European countries which have been engaged in marine researches in recent years.

We have received from the British Museum (Natural History) a report by Dr. S. F. Harmer on Cetacea stranded on the British coasts during 1914. The arrangements made by the Board of Trade for reporting such strandings a couple of years or so ago have been continued, and in some respects amplified, a notable innovation being the dispatch of the lower jaws of the smaller species, and of a plate of whalebone in the case of the baleen-whales. Up to the outbreak of the war returns were received regularly, but afterwards, when coastguards had their hands full of other duties, there was a great falling-off in the returns, this being particularly the case during the period from August to mid-October, when the items should have been at their maximum. The whole annual record of strandings amounted only to fifty-seven, as compared with seventy-six in the previous year. It may now be regarded as definitely established that the porpoise is by far the most abundant of the smaller cetaceans visiting the British coasts, and it may be added that the series of lower jaws of this species received at the museum has enabled Dr. Harmer to make some valuable observations with regard to the rate of growth, wear, and variation of the teeth—such observations indicating that a so-called species founded on such differences is invalid. Four records of the dolphin and the same number of the white-beaked dolphin are included in the list, which also comprises a Sowerby's beaked whale taken alive in September on the Wexford coast.

A recently published number of the *Indian Journal of Medical Research* (vol. ii., No. 3) begins with a memoir by Mrs. Helen Adie on the sporogony of *Haemoproteus columbae*, the "halteridium" parasite of the blood of the pigeon. The development was studied in *Lynchia maura*, the hippoboscid fly which is a common parasite of pigeons, and well known to be the invertebrate host of the Hæmoproteus. Whereas, however, previous investigators had not been able to find any stage of the parasite more advanced than the "ookinete" or "vermicule" in the Lynchia, and were of opinion that the parasite was inoculated into the pigeon by the fly in this phase of its development, Mrs. Adie has found that the ookinete-stage is succeeded by a process of sporogony exactly similar to that of the malarial parasites, with oocyst and sporozoite stages, ending with vast numbers of sporozoites in the salivary glands of the fly. The author states that no blood-parasites other than the Hæmoproteus were to be found in the pigeons; this statement, if correct, disposes of the obvious criticism, that the sporogony seen might be that of some Proteosoma parasite of the birds. Mrs. Adie is much to be congratulated on having filled an important gap in the knowledge of the development of these parasites, and on having discovered a series of stages which had escaped the notice of such competent observers as the Sergent brothers and Aragao. It is to be regretted that all recent writers on the development of malarial parasites use the term "zygote" in an entirely incorrect manner; the term should be used to mean the body formed by the union of the two gametes, and should therefore be applied, in the present case, to the rounded stage preceding the ookinete, and not to the oocyst-stages following the ookinete-stage.

Attention may usefully be directed to a paper on the care of old trees, illustrated by plates, in the *Kew Bulletin* (No. 2, 1915), since this is a subject often sadly neglected by those in charge of our parks and gardens which contain historic or interesting trees. The questions of breakages by wind, injuries by fungi, proper watering, feeding, and mulching, and the proper treatment of wounds are dealt with fully.

Mr. T. Petch contributes to the Annals of the Royal Botanic Gardens, Peradeniya (No. vii., vol. v.), a useful preliminary note on the genera Hypocrella and Aschersonia, fungi parasitic on scale insects which he has studied in connection with the type specimens preserved in the principal European herbaria. As a result of his investigations Mr. Petch has been able to clear the ground for his full paper, to be illustrated, we hope, with the drawings, by setting out the synonymy of the species examined. The species of the western hemisphere, with the one exception of *Hypocrella camerunensis*, found in Brazil and Africa, are distinct from those of the eastern hemisphere.

The description of new species of plants from China occupies the greater part of No. xxxviii. of vol. viii. of the Notes of the Royal Botanic Garden, Edinburgh, and are largely the result of Forrest's and Ward's collecting in western China. Among them are six new Rhododendrons to swell the long list of this important Chinese genus, and one of them, *R. Wardii*, W. W. Smith, with its large flowers, "slightly fleshy bright yellow with the faintest touch of crimson on interior at base," fills the heart of the cultivator with an eager desire to introduce the species. Messrs. Lace and Smith also describe three Rhododendrons from Indo-Burma, two of which were previously but very imperfectly known; all three species are figured.

The *Kew Bulletin*, No. 2, 1915, contains several papers dealing with systematic botany and matters of general botanical interest. *Diospyros ebenaster*, a widely cultivated tree in the tropics, often considered to be a native of the Philippine islands, is almost certainly indigenous in the West Indies, whence it has been introduced to other countries at a very early date. Mr. Sprague enumerates the sections of the South African species of Loranthus, the outcome of his work on the genus for the "Flora Capensis," and there are descriptions of twenty new plants, ten from Africa and ten from Australia, India, Malaya, etc. Of more general interest is a paper on the germination of coco-nuts, with reference particularly to the age of the trees from which seed nuts should be taken. There appears to be no reason, especially in the light of recent experiments in the island of Nevis, why nuts from good trees in their third year of bearing should not be used despite the prevalent beliefs usually held on the subject that to use such nuts is to court disaster. The doubts entertained recall the words of Sir Thomas Browne: "So these Traditions how low and ridiculous soever, will find suspition in some, doubt in others, and serve as tests or trials of Melancholy and superstitious tempers for ever."

There are few better Transactions than those of the Norfolk and Norwich Naturalists' Society, and their high place in science is well maintained by their latest publication, vol. ix., part v., 1913–14. The work in this goodly volume of some 200 pages is admirable: and we think that the members of the society receive a full return, or more than full, for their subscriptions. We would also congratulate the hon. secretary, Dr. Sydney Long, on the care which he has given to the editing of the volume. The president of the society, Miss Alice Geldart, in her address to the annual meeting, announced that the society has published the "Flora of Norfolk," edited by Mr. W. A. Nicholson. The subject of her address was the lives of some of the earlier Norfolk botanists; and it is a model of careful and sympathetic biography. Next comes Mr. Wormald's paper, well illustrated, on the courtship of ducks; then the valuable reports on that sanctuary of birds and of wild plants, Blakeney Point. Other monographs, of no less value, are contributed by Dr. Brenchley, Mr. Burrell and Mr. W. G. Clarke, and Mr. Rivière; and there is a wealth of shorter papers. Altogether, the volume deserves the highest praise as the publication of a county scientific society.

Mr. E. Mancini contributes an account of the Italian earthquake of January 13 to the *Revue générale des Sciences*, etc. (March 15, pp. 146–48). Most of the details contained in it have already appeared in our columns (vol. xciv., p. 565; vol. xcv., pp. 76–7). Mr. Mancini remarks that the exact position of the epicentre is still undetermined, but that, according to Dr. Agamennone, there may have been two separate foci in action at, or nearly at, the same time (see Nature, vol. xciv., p. 565). He estimates the total number of lives lost at more than 25,000. The number of persons saved at Avezzano was 2300 out of 13,000, so that the death-rate in that town must be reduced to 82 per cent.

A biographical notice of the late Prof. Adolfo Venturi appears in a recent number of the *Rendiconti della R. Accademia dei Lincei* (vol. xxiv., 1915, pp. 277–83). Born at Florence on September 22, 1852, he studied mathematics in the University of Pisa, obtaining his diploma in 1875. Shortly afterwards, he became mathematical teacher in the lyceum of Como, and in 1888 was appointed to the chair of geodesy in the University of Palermo. His work while at Como dealt mainly with the motion of the earth about its centre of gravity and the perturbations of comets and minor planets. At Palermo, he naturally turned his attention to geodetic problems, and afterwards to terrestrial refraction. Prof. Riccò in 1896 had begun a gravimetric survey of eastern Sicily, and this was extended by Venturi to the western half of the island. After a brief illness, Prof. Venturi died at Palermo on December 28, 1914.

Messrs. Edward Stanford, Ltd., have issued Nos. 11 and 12 of their series of war maps. No. 11 shows the eastern theatre of operations, and includes Hungary, Galicia, Bukowina, Poland, and parts of the neighbouring areas. The map is on a scale of eighteen miles to the inch, and shows contours coloured on the layer system, which demonstrate clearly the Carpathian heights between the northern plain in Poland and the plain of Hungary. Railways, roads, rivers, and numerous towns and villages tend to facilitate reference in connection with the official *communiqués*. This very useful publication is 33×45 in. in size, and the price ranges from 7*s.* 6*d.* to 17*s.* 6*d.*, according to style of mounting. No. 12 is devoted to the Dardanelles area of conflict; the sheet includes seven separate maps. There are plans of Constantinople, Smyrna, and Skutari; large-scale maps of the Dardanelles from Kum Kaleh to Gallipoli, and of the Bosphorus; a map of the Sea of Marmora and its entrances, and a map of Turkey-in-Europe and the western portion of Asia Minor. The two latter maps show contour at intervals of 1000 ft., and indicate relief by colour shading.

Scientific Paper No. 239 from the Bureau of Standards contains a description of a vibration electrometer by Mr. H. L. Curtis, of the bureau. The needle of the instrument consists of a light aluminium vane, 2 cm. square, supported with its plane vertical by a bifilar suspension, which extends both above and below the vane. Two fixed plates, 1×2 cm., are placed on each side of the vane, with their planes also vertical. The distances of the plates from the vane can be varied from 0·5 to 1·0 mm. To obtain complete control of the damping the whole instrument is enclosed in a bell jar which can be exhausted. The vane is connected to a battery giving 240 volts, and the alternating electromotive force to be detected is applied to the plates, which are cross connected, as in the quadrant electrometer. Resonance is secured by adjusting the tension or length of the suspension, and the deflections are read by the telescope and scale method. With the air pressure reduced to 0·005 mm. of mercury the deflection per volt at 50 cycles per second is 6 cm. on a scale at a metre distance, and the least current the instrument will detect is 10^{-11} ampere. The behaviour of the electrometer agrees very closely with the theory developed by the author.

Technologic Paper No. 41 of the Bureau of Standards, Washington, by R. S. McBride and J. D. Edwards, deals with the lead acetate test for hydrogen sulphide in illuminating gas, and is of interest here, as sulphuretted hydrogen is now the only impurity in coal gas officially controlled. It is pointed out that the various modes of testing in use are not all directed to the same end, since some of the tests are designed to detect as small traces of hydrogen sulphide as possible, while others aim to give a negative test when a permissible amount is not exceeded. The previous work of W. J. Dibdin and R. G. Grimwood, R. Forbes Carpenter, and C. J. Ramsburg, is described and criticised, and details of a new set of experiments are given in which some of the errors ascribed to the earlier work are avoided. The variations due to the kind of paper, concentration of lead acetate solution, preparation and condition of the paper, humidity of the gas, rate of flow and time of exposure, and the various forms of testing apparatus have been studied separately. Based on these results a method is recommended for use which is claimed to be quick and convenient, and gives reproducible results.

A recent publication among the Oxford pamphlets is by Prof. J. O. Arnold, the professor of metallurgy in the University of Sheffield, entitled "British and German Steel Metallurgy." It was inspired, as the opening sentences show, by an article by Prof. Rein, of the University of Vienna, on "Civilisation and 'Kultur.'" The pamphlet attempts to show (1) that German steel metallurgy owes far more to British inventors than British steel metallurgy owes to German inventors, and (2) that the steel department of the University of Sheffield has done work greatly superior to that of the corresponding department at Charlottenburg. The following claim bearing on the latter thesis may be quoted from the pamphlet as typical of the style:—"There are about twenty-nine constituents or sub-constituents of steel and iron. Of these, twenty-six have been discovered in Sheffield, the steelopolis of Great Britain; three in Middlesbrough, its ironopolis; and the record of Charlottenburg in this branch of research is absolutely blank." We confess to regretting that the author has by this publication placed himself in the category of those who desire to minimise the debt that British science owes to German science. It would have been better if the task had not been attempted.

The *Engineer* for April 9 directs attention to some absurd British methods of dealing with drawings received from consulting and other engineers on the Continent. In a recent instance, detail drawings received from abroad showed particulars all dimensioned metrically. The British drawing office, with much care, translated these dimensions into feet, inches, and fractions. Some typical examples of the results are noted: A bolt circle diameter of 418 mm. was translated to $16\frac{7}{16}$ in. + $\frac{1}{64}$ in.; 21 mm. clearance holes for black bolts became $\frac{13}{16}$ in. + $\frac{1}{64}$ in. The chances of mistake in this method are considerable, and include translation errors, errors in ordering drills to such odd sizes, and errors in marking off and making jigs and templates. In addition, trained mechanics have an ingrained fear of dimensions in sixty-fourths, and will spend much more time over these figures than over even numbers. The commonsense method is to give the workmen the drawings in metric system and supply them with metric rules. In view of the continually increasing demand from the Continent for material manufactured in this country, it is probable that we are on the eve of a very considerable extension of the use of the metric system in our workshops and factories.

The ninth report of the Royal Commission on Sewage Disposal has now been issued. Part ii. consists of a brief statement relating to the disposal of sewage in rural areas where sewers are not available. The question as to whether a rural committee should adopt some dry method of disposal, or provide sewers and purification works, depends upon whether a water supply is laid on to the houses or not. If it is, a sewerage system is almost inevitable; but if not, then dry closets may be used satisfactorily under proper supervision. In a minority report on this subject Sir William Ramsay appears to favour the extension of dry systems, even when a water supply is laid on to houses, mainly on the ground that the valuable nitrogen of domestic sewage ought to be returned to the soil. *Engineering* for April 9, commenting on the report, sympathises with Sir William Ramsay's desire to put some check on such a waste; but points out that epidemic disease amongst the people involves a greater waste, and there is no denying the beneficial effects on health which follow the acquisition of a pure and abundant water-supply, or the evils which, literally, lie at the door of ill-managed "dry" systems.

OUR ASTRONOMICAL COLUMN.

Comet 1915*a* (Mellish).—The following ephemeris of Comet Mellish is a continuation of that calculated by Messrs. Braae and Fisher-Petersen, and printed in a circular issued by Prof. Elis Strömgren:—

	R.A. (true) h. m. s.	Decl. (true)	Mag.
April 20 ...	18 24 59 ...	−5 36·0	
22 ...	27 6 ...	6 13·6 ...	7·6
24 ...	29 12 ...	6 54·4	
26 ...	18 31 18 ...	−7 38·8 ...	7·4

The comet is moving in the constellation of Aquila, and lies to the west of λ Aquilæ and is about equidistant from η Serpentis, which star is further to the westward.

The Chromospheric Spectrum without an Eclipse.—In the March number of the Proceedings of the U.S. National Academy of Sciences, W. S. Adams and Cora G. Burwell describe briefly the results of an investigation of the flash spectrum without an eclipse in the region λ 4800 and λ 6600. The full paper will soon be published as No. 95 of the *Contributions from the Mount Wilson Observatory*. In the first place, it is interesting to record that the total number of lines measured upon the negatives taken without an eclipse is greater than that obtained from eclipse negatives. Thus Mitchell's beautiful chromospheric spectrum of 1905 showed 901 lines, while those here measured number 1027 lines. It is further pointed out that in the photographs taken without an eclipse the wave-lengths of the bright lines have been determined with reference to the dark lines at the limb. A comparison of 512 lines shows that the difference between the wave-lengths of the bright lines and the dark lines at the limb gives a value −0·002 Angstrom. The preponderance of the negative sign in the case of the individual elements makes it fairly probable that this quantity may be regarded as real. Reference is made also to the marked gain in accuracy for the Mount Wilson results, attributed notably to the greater linear scale of the photographs. Some peculiar characteristics of the dark line spectrum of the sun's limb as seen on the photographs of the flash spectrum are briefly decribed, and the identification of the elements to which these lines belong is suggested as a research of decided interest.

The Rotation of Nebulæ.—Prof. Percival Lowell has forwarded two very interesting photographs of the spectra of nebulæ taken by Dr. V. M. Slipher, both of which are briefly described by the latter. The first is the spectrum of Virgo nebula, N.G.C. 4594, taken in April, 1913, with an exposure of 30 hours, together with comparison spectra of vanadium and iron. It was from this photograph and two others, also taken in the same year, all of which showed the nebula lines inclined, that the first direct evidence that nebulæ rotate was secured. In the photograph sent the slit was placed east and west, and the rotation in the sense that brings the west side of the nebula towards the earth. In addition to their inclination the lines have a large displacement, which makes the solar band G nearly coincident with the iron line λ 4326, thus indicating a velocity of recession of 1100 kilometres. Dr. Slipher remarks that this was far the highest velocity then known, but "further observations of nebulæ here have revealed others as high." The second photograph is of the spectrum of the Crab nebula, N.G.C. 1952, taken in February of the present year, with 18 hours' exposure, and similar comparison spectra. This is described as "the most remarkable nebula spectrum known." Upon a rather strong continuous background are found bright lines typical of gaseous nebulæ lines. Thus the lines $\lambda\lambda$ 5007, 4959, 4861 ($H\beta$), 4686, 4341 ($H\gamma$), seem to be present. The strange appearance of these bright lines is described as follows:—"They seem to be split into doubles, best seen in λ 5007 and λ 4861 (the inside components of λ 4959 and λ 5007 would be blended). The distance between the components changes with the position in the nebula. It reminds one of the Zeeman effects in a non-uniform magnetic field and implies the origin to be within the atom. However, the maximum separation is quite enormous—40 tenthmetres. A plausible explanation of the spectrum as velocity effects has not occurred to me as yet."

The "Scientific American" and Astronomy.—The Paris Observatory and its work is the subject of an interesting article to the *Scientific American* (March 13) by Prof. G. A. Hill, of the United States Naval Observatory. The author accompanies his text with two excellent reproductions showing the large transit circle and the eye end of the equatorial Coudé. The history of this famous institution is briefly sketched, and special reference made to the lunar photographs taken by MM. Loewy and Puiseux. In the issue of the same journal for March 20, Abbé Th. Moreux describes the planet Saturn, its ring system, and the satellites, and accompanies his remarks with a large number of reproductions from early and late drawings. Such articles popularly written and finely illustrated render a great service in disseminating astronomical knowledge, and we hope to direct attention to similar contributions in future issues.

EXPERIMENTAL STUDY OF THE MECHANISM OF WRITING.

Of recent years considerable advances have been made in the experimental study of the complex processes of reading and writing, mainly in the interests of a new experimental science, which is at present calling itself "experimental pedagogy," and at recent meetings of the British Association the Educational Science Section has devoted a good deal of attention to such work. In the Proceedings of the Royal Society of Edinburgh a further contribution to the experimental analysis of the writing process is made in a paper by Mr. James Drever, on the analytical study of the mechanism of writing.

Looked at from the outside, and regarded purely as a mechanical process, the writing act consists of certain movements and co-ordinations of movement of the fingers, hand, forearm, and shoulder. Of these the hand movements and the work of the fingers are the most important. By employing various pieces of comparatively simple apparatus it is possible to separate hand and finger movements, as well as to isolate for observation and study both the pressure of the fingers in holding the writing instrument and also the pressure placed upon the writing point.

To Prof. C. H. Judd, of Yale, we owe the original idea of a simple piece of apparatus which enables the experimenter to separate hand and finger movements. This apparatus consists essentially of an attachment for the fifth metacarpal, which carries a pencil or style for recording the movement of the hand. The original form of the apparatus was defective in several respects, but a modified form described in the above-mentioned paper seems to eliminate most of these defects. By comparing the record of the hand movement with the actual writing we can determine the part played by finger movement. It should be noted, however, that there is one movement of the hand in writing which cannot be recorded in this way. That is the movement known as pronation—the movement round the axis of the wrist.

Records taken with Judd's apparatus yield several interesting results. Some writers use little, if any, finger movements, and most writers, when writing at maximum speed, and especially with the pencil, approximate to this type. Ordinarily, however, in careful adult writing in this country, all the finer work in the formation of the letters is due to finger movement, and this to a greater extent in pen writing than in pencil writing. As a rule the writers themselves are quite unconscious of such finger movements. In the writing of the child, who is merely at the learning stage, there is little finger movement, but finger movements develop as facility is acquired.

The isolation of grip pressure in writing is secured

FIG. 1.

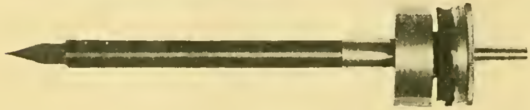

FIG. 2.

by an apparatus consisting essentially of a double-walled rubber capsule, inserted into the pen or pencil holder to take the grip (Fig. 1). The space between the walls, and also the inner space, are filled with mercury. A capillary glass tube passes into the inner space, and its top is connected by means of rubber tubing in the usual way with a recording tambour. Any variations in pressure on the outer wall of the capsule are in this way transmitted to the tambour and graphically recorded by the marking lever on a smoked drum.

Very little work has hitherto been done in the study of grip pressure. The most striking feature in the grip pressure curve obtained is its rhythmical character (Fig. 3, VI.). With the adult this rhythm is extremely regular, but it is absent in the earliest writing of children, first appearing about the age of eleven, and then with marked irregularities (Fig. 3, VII.). In writing with the pencil the grip pressure is considerably greater than in writing with the pen, and the difference between maxima and minima in the rhythm also greater. Finally, there are in adult writing definite indications that a word or even phrase is written with one total impulse.

Several different forms of apparatus have been employed for obtaining a record of point pressure in writing. Continental investigators have employed a writing plate, either connected directly with a lever for marking on a smoked surface, or resting on an air cushion pneumatically connected to a recording tambour. In Mr. Drever's apparatus the pen or pencil is attached to a receiving tambour, which forms the top of the pen or pencil holder (Fig. 2). This last form of apparatus is exceedingly simple and convenient for use with children.

The study of the point pressure curve has already yielded some interesting results, which bear not only upon education but also on the study of mental defects. In normal adult writing two types of pressure curve were early and easily distinguished, and it is possible to distinguish three. The first, which is known as the masculine type, shows a single definite maximum of pressure for each word, and increased pressure with increased speed of writing (Fig. 3, IV.). The second, known as the feminine type, shows several maxima of pressure in each word, and diminished pressure with increased speed of writing. The third, which might be called the clerical or mechanical type, shows great uniformity of pressure in each word, and practically no change of pressure with increased speed of writing; further, there is comparatively little increase of speed beyond the ordinary rate, and in some cases the speed actually

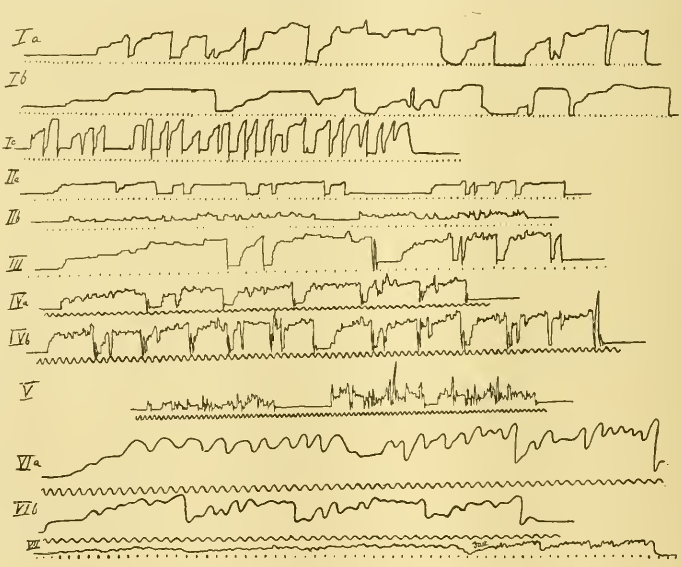

FIG. 3.

I. to III. Point pressure tracings from children. Time record in seconds by Jacquet Chronograph.
I*a*. Child of six. Words "The cow gives us milk."
I*b*. Child of six (first attempt at script). Words "A man can."
I*c*. Child of six (printing). Words "A man can run"
II*a*. Pencil writing, and II*b*. Pen writing of child of eight. Words "Moray House School," written twice in each case.
III. Child of eleven. Pencil writing. Words "Moray House School," written twice.
IV. and V. Point pressure tracings from adults. Time record in $\frac{1}{5}$ secs. by vibrating spring.
IV*a*. Pencil writing, ordinary rate. Words "Moray House School," written twice.
IV*b*. Pencil writing by same subject, maximum rate. Words "Moray House School," written four times.
V. Pen writing, slow and fast. Words "Moray House School," written once slow and twice fast.
VI. and VII. Grip pressure tracings from adults and child of eleven. Time records for adults in $\frac{1}{5}$ secs. and for child in secs.
VI*a*. Adult pencil writing. Words "Moray House School."
VI*b*. Adult pen writing. Words "Moray House School Moray."
VII Child's pencil writing. Words "Moray House School" twice, slow and fast.

diminishes, while the subject thinks he is writing faster.

The pressure curves obtained from children differ from all the adult types. A flat-topped curve had been considered until recently the characteristic child's curve (Fig. 3, II a). This curve does not, however, represent the first stage in the acquiring of writing. The first curves obtained are more or less characteristically drawing curves (Fig. 3, I.). Such curves are best seen where the child begins with printed letters rather than script (Fig. 3, I.c). In this case each stroke requires a definite and separate impulse, and this is well marked in the pressure curve. In the earliest script the curve seems merely irregular, but this is due to variations in the drawing unit with which the child is dealing, which may be a single stroke, a letter, or a group of letters. The second stage in learning to write is marked by what was formerly called the child type of pressure curve, a curve with a strikingly regular, flat top, which is still a drawing curve, though the child is now drawing the whole word. This curve passes gradually into the curve with rippled top of adult writing, the time when the transition can really be said to take place being about the age of ten or eleven (Fig. 3, III.). The transition seems to mean two things. In the first place the necessary co-ordinations are established to such an extent that the mechanism of writing works without attention to the individual strokes and forms which the hand is making. In the second place, and partly because of this, writing has ceased to be drawing and has become language, the rhythmical variations in point pressure corresponding to the rhythmical variations in grip pressure, and being analogous to a certain extent to the rhythm of speech. When this stage is reached the impulse under the direction of which writing takes place is distinctly a word impulse, and sometimes even a phrase or sentence impulse.

It has also been found that the writing of defectives fails to show this characteristic rhythm of adult writing, while drugs like alcohol tend to impair the rhythm and ultimately to break it down altogether, apparently because of their effect on co-ordination. It is also somewhat interesting to find that the pressure curve is almost as characteristic of an individual as his signature, and persists even in left-hand writing without previous practice. There is evidently a wide field for investigation in this direction, and perhaps we may yet see the development of a real science of graphology based upon such investigation.

FLORA OF ADEN.[1]

PROF. BLATTER has brought together an interesting account of the vegetation of the Aden peninsula, in which, after summarising the history of botanical exploration of this region from the earliest times, he gives data regarding physiography, climate, soils, tabulated lists of the plants, and brief notes on their distribution, origin, means of dispersal, etc. No references are made to work on plant ecology, but a comparison of the characters of the Aden vegetation with that of other arid regions, as investigated particularly by the Carnegie Institution botanical staff in North American and North African deserts, brings out some points of considerable ecological interest.

The first botanical description of Aden was given by Ibn Batuta in about 1330, and it consisted of the brief statement that "there are neither seeds nor trees nor water." Though Aden is not so entirely destitute of vegetation as this famous traveller supposed, the impression it produced upon much more recent botanical visitors was scarcely more favourable. Sir J. D. Hooker, in 1847, described Aden as being "upon the whole the ugliest, blackest, most desolate, and most dislocated piece of land, of its size, that ever I set eyes upon, and I have seen a good many ugly places"; but he mentioned the comparatively fertile lower valleys, thickly studded with beautiful-flowered shrubs and small trees. Prof. Blatter's compilation is based largely upon the scattered reports and collections made by residents and visitors, and shows that Aden, despite the fact that it consists largely of "bare naked rocks which cannot find their equal in any part of the world as regards dryness, infernal heat, and barrenness," possesses an interesting and surprisingly varied vegetation.

The volcanic rocks forming the greater part of the Aden peninsula, which is about fifteen miles in circumference, are practically devoid of plant life; even lichens are scarce on the sun-baked and disintegrating rock-surfaces. These lofty and jagged rocks, rising in places to 1700 ft. altitude, are scored by steep gulleys and mostly run straight down to the shore, but here and there the lower slopes are gentle or almost flat, and in such places the clayey soil retains rain-wash, which elsewhere quickly runs off or percolates through the loose soil, and the vegetation in these parts is fairly rich. Apart from such habitats, the rigorous character of the conditions with which the Aden plants have to contend may be realised from the facts that there are no permanent streams or springs or marshes or ponds; the annual rainfall rarely exceeds six or seven inches in the wettest years; no rain may fall for two years at a time, and when it does fall it usually comes down in a torrent lasting for a day or two, changing the dry gulleys into turbulent streams which quickly dry up again.

The Aden flora consists of 250 species of flowering plants, including ten trees, fifty-eight shrubs, forty-six undershrubs, and 136 herbs. The work of the Carnegie Institution botanists has shown that in the most arid regions of the earth, where the rainfall is extremely scanty, infrequent and irregular, what were formerly regarded as the typical desert-plants, namely, species with fleshy water-storing leaves and stems (cacti, etc.), are almost or entirely absent, and that the desert type *par excellence* is not succulent, but sclerophyllous. This term is applied to plants which do not store up water but contend with the extreme aridity of their environment by various adaptations for reducing water-loss to a minimum—reduced leaf surface, dense hair-covering, waxy cuticle, gummy epidermis, development of leaves or branches or both as spines, etc. From Prof. Blatter's list such plants appear to be dominant in the vegetation of Aden; fleshy species are practically confined to the sea-coast. A further point of interest is that about half of the herbaceous plants listed for Aden are short-lived annuals, which grow in the clayey soil of the flats and gentle slopes where water can be retained in the surface layers long enough for these plants to complete their brief life-cycle whenever rain comes. This, again, is a characteristic feature of the typical desert flora with clayey oases.

The records of the Botanical Survey of India contain so much that is, at any rate potentially, of general interest to students of plant ecology, that while the material they contain is welcome and useful, it is much to be hoped that the survey workers will make themselves acquainted with what has been and is being done on modern ecological lines, so that they may

[1] "The Flora of Aden." By Ethelbert Blatter, Professor of Botany at St. Xavier's College, Bombay. Records of the Botanical Survey of India. Vol. vii, No. 1. Calcutta, 1914. Pp. ii+79; 5 plates; 1 map.

correlate their results with those obtained in other regions by the application of methods which alone can make a botanical survey what it is now generally expected to be—a correlated study of the plant communities and the plant habitats of the area surveyed.

F. C.

ORNITHOLOGICAL NOTES.

At the annual meeting of the Royal Society for the Protection of Birds, held at the Middlesex Guildhall, on March 11, when the Ranee of Sarawak presided, an optimistic tone prevailed in the first portion of the report for 1914, as several of the schemes and objects for which the Society had long been labouring were apparently on the point of realisation. Then came the war, when all these fair prospects—particularly the expected passing of the Government Plumage Bill—were dissipated, to be renewed, it may be hoped, at the conclusion of the war. In other respects the work of the Society was, on the whole, satisfactory; but finance is a matter on which there is serious ground for anxiety, as a falling-off in subscriptions during the current year is almost inevitable.

The condor forms the subject of the first article in the March number of the *Children's Museum News*, where particular reference is made to the long period taken by these birds to attain the adult plumage. Hatched during the height of the southern summer, the young exchange their white nestling dress for a uniformly brown garb, which is not finally discarded until the seventh year, in February or the early part of March. Although able to fly when a year old, young condors do not leave their parents until the completion of their third year.

In the course of a wonderfully illustrated article on a breeding-colony of buff-backed herons, published in the March issue of *Wild Life*, Mr. B. Beetham directs attention to the small size of the nests of these birds, which alone renders it possible for so many to be crowded into a single bush. So heavily weighted, indeed, are some of the boughs that they hang almost vertically; and it is little short of marvellous how the eggs and young are retained in the shallow, cup-like nests, generally overhanging a lagoon, into which the hapless offspring may be precipitated by a gust of greater strength than usual. The nests are devoid of lining, and in some cases so flimsy in structure that the pale blue eggs are visible from below.

The nesting-habits of fulmar-petrels on a precipitous cliff in the Orkneys form the subject of an article by Mr. O. G. Pike in *British Birds* for March. The author arrived on the scene in the second week in July, when most of the young were hatched; but he was able to secure a couple of photographs of sitting birds, as well as one of a downy nestling. Each female lays but a single egg, and at a very early stage the young bird is capable of indulging in the distinctly petrel-trait of discharging a forceful jet of evil-smelling green oil from its mouth in the face of a real or supposed enemy.

To the Journal of the Straits Branch of the Royal Asiatic Society for December, 1914, Mr. J. C. Moulton, curator of the Sarawak Museum, contributes a list of Bornean birds. In an appendix to Hugh Low's "Sarawak," published in 1848, the number of species then recognised was fifty-nine; this was raised in 1889 in a list drawn up by the late Mr. A. H. Everett to 536 (exclusive of thirty-four from Palawan), while in the present list the number is again augmented to 555; and this, too, despite the fact that several birds formerly regarded as distinct species have been relegated to the rank of local races.

According to the report in the January number of the *Emu*, the fourteenth annual session of the Royal Australasian Ornithologists' Union, held in Melbourne in November, 1914, was a thorough success, a number of interesting excursions being taken and several papers read. In the same issue Mr. A. J. Campbell directs attention to the apparent extermination of three beautifully coloured species of parrots—namely, the scarlet-shouldered *Psephotus pulcherrimus*, the chestnut-shouldered grass-parrot (*Euphema pulchella*), and the night-parrot (*Geopsittacus occidentalis*), all of which were to be met with a few years ago in Queensland or the neighbouring districts. Their disappearance is attributed to domesticated cats run wild, aided by bush-fires and the spread of cultivation.

In the *Zoologist* for March, Prof. J. C. Patten describes an immature aquatic warbler picked up at Tuskar light-station, County Wexford, on August 9, 1913. The paper is illustrated by a plate showing how the plumage of this species differs from that of the sedge-warbler at the same age. In the aquatic warbler the back is marked by streaks of black and buff, which are but slightly developed in the sedge-warbler; both webs of the middle pair of tail-feathers are also margined with buff, and all the tail-feathers are likewise longer, narrower, and more pointed than those of the sedge-warbler. The Tuskar bird is the second of its kind taken in Ireland; the number of specimens recorded from Great Britain (England) is seventeen.

R. L.

MOUNTAIN GEOLOGY.

In the *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève* (vol. xxxviii., pages 69–168) M. Louis Duparc and Mme. M. Tikanowitch continue their work on the Ural Chain by an account of its rocks to the east of the main watershed and in the upper basin of the rivers Kakwa and Wagran. This, the fourth of their contributions to the geology of that chain, is prefaced by a sketch of the physical features of the district, the illustrations to which show that it consists of huge hills rather than of rugged mountains. The rocks are partly sedimentary, arenaceous, or slaty argillaceous, with some quartzose crystalline schists; partly igneous. Of the latter a very complete petrographical study has been made, including chemical analyses of the principal types, several of which are very interesting. Among those of deep-seated origin are the following: quartz-bearing micaceous diorites (evidently allied to tonalites) and gabbro-diorites (in which probably the hornblende is secondary), olivine-gabbros, and massive dunites. Besides these and serpentines, are tilaite (a variety of eucrite) and pyroxenites. This association is interesting, for it often exists, more or less completely, in other regions, and suggests certain modes of magmatic differentiation. The dyke-rocks include hornblendic berbachites and various dioritic porphyrites, besides amphibolites, in some at least of which the hornblende appears to be secondary. The article ends with a description of the crystalline schists which, however, do not appear to be of any unusual interest. The memoir, illustrated by twelve photographic figures of the microscopic structure of the more interesting rocks, forms a most welcome addition to petrology, the more remarkable when we learn the difficulties with which the authors had to contend in their three visits to this region, in consequence of the sparse population, the want of roads, and the absence of maps.

In the next fascicule (pp. 169–98) M. Jules Favre describes the relation of the plant-life to the geology of the Salève. This mountain, which rises about 3000 ft. above Geneva, consists of limestones and shales (Upper Jurassic and Neocomian), with Middle Tertiary sandstones, chiefly molasse, and glacial deposits. Apart from the effects of altitude, the flora is much affected by the nature of the rock on which it grows, and besides this, a small colony of special plants generally accompanies any local physical peculiarity. Of this association the large erratics of Alpine granite and schists afford a remarkable instance. *Asplenium septentrionale* is the only phanerogamous plant found on them to which rocks, in the High Alps, it is practically restricted.

BLOOD-PARASITES AND FLEAS.

FOR the past five years Prof. E. A. Minchin and Dr. J. D. Thomson have been engaged upon the investigation of the rat trypanosome, *Trypanosoma lewisi*, with special reference to its relation to the rat flea, *Ceratophyllus fasciatus*. The results of this laborious and painstaking research are now published in the *Quarterly Journal of Microscopical Science*. They form a comprehensive monograph which occupies the whole of the last part of this journal (vol. lx., part 4) and will undoubtedly be a standard work of reference for students of these very important blood-parasites. The fact that the authors have dissected and examined more than 1600 fleas in the course of their investigations shows the thoroughness with which the work has been carried out, while the artistic treatment and accuracy of detail contributed by the illustrations, for which due acknowledgment is made to Miss Rhodes, leave nothing to be desired. *T. lewisi* is fortunately a non-pathogenic parasite, at any rate so far as the rat is concerned, and it cannot live at all in human blood. It therefore forms a much more suitable type for general study than such deadly species as those which are conveyed by the tsetse-fly in Africa, and are responsible for fly-disease amongst horses and cattle, and for sleeping sickness in human beings. The authors give a very useful account of the technique employed in their investigations, and, incidentally, throw a good deal of light upon details of the anatomy and histology of the flea.

The flea, of course, receives the parasite with the blood which it extracts from the rat, but apparently it cannot infect the rat by inoculating trypanosomes into it through the proboscis. The rat is supposed to become infected through the mouth; in the process of licking its fur it takes in trypanosomes with fæcal matter deposited by the flea; or it may become infected by eating infected fleas.

While in the flea the trypanosome is confined throughout its whole development to the digestive tract, where it undergoes extensive asexual multiplication and passes through a number of more or less distinct phases, some of which are intracellular in the epithelium of the stomach. No sexual phenomena have been detected, and the authors agree with Miss Robertson that such phenomena have not as yet been satisfactorily demonstrated in the case of any trypanosome.

CHANGES OF RELATIVE LEVELS OF LAND AND SEA.

AMONG the different kinds of evidence showing that changes in the relative levels of sea and land are going on all over the globe, the forms assumed by coast-lines are now recognised by geologists as being the most convincing and satisfactory. Sea-erosion, acting only along shore-lines, and sub-aerial denudation, operating over the whole land-surfaces, result in features of such clearly differentiated character that no unbiassed observer can fail to recognise their great significance and value. When we find long, narrow, deep, and winding inlets from the sea into the land ("fiords," etc.), it is obvious that such features could not result from the cutting back of the coast-line by the sea, but that they are old river-channels that have been drowned by the sinking of the land. On the other hand, sea-beaches, with caves, fan-taluses, and other signs of shore work, occurring at various heights above the present sea-level, speak, quite as unmistakably, of elevation having taken place.

The illustrious American geologist, James Dwight Dana, when accompanying the United States Exploring Expedition under Wilkes, had the opportunity of visiting many coral-reef islands, and we are indebted to him for first showing, in 1849, the value of the evidence afforded by coast-lines, where bounded by "encircling" or "barrier" reefs, of subsidence having taken place. These valuable observations of Dana seem to have been almost completely overlooked until quite recent years, and it is only fitting that to a fellow-countryman of his should fall the task of recalling and developing this pioneer work.

Where a coral-reef encircles a land-mass it is evident that the presence of "fiords" or their equivalents in the central island supplies clear evidence of submergence having taken place, though possibly this may not be the latest of the movements that have occurred. On the other hand, the existence of islands composed of upraised coral-rock, with sea-caves and shore deposits at different stages, up to more than 1000 ft. above the present sea-level, supplies equally clear evidence of movements in an opposite direction having taken place. The late Prof. Alexander Agassiz published a very valuable series of reports, abundantly illustrated, concerning these upraised Pacific reefs, and we now have the promise of equally important descriptions by Prof. W. M. Davis, also of Harvard, of the cases in which the proofs of subsidences can be no less satisfactorily made out.

The general result to which these various observations appear to point is that, over the whole area of the Pacific, areas of elevation and others of subsidence can be clearly traced, though the movements were often interrupted and sometimes reversed; nevertheless, it must be admitted that in some cases the evidence seems puzzling and contradictory—islands with clear evidence of elevation lying in close proximity to others which have clearly subsided. Geologists will not, however, be unprepared for the occurrence of such seeming anomalies; they will only recognise that, eventually, actual fault-lines may be traced by such means in the oceanic areas. At the same time it may be well to bear in mind the caution suggested by Darwin in his correspondence with Semper that, however clear may be the evidence in favour of any special theory of coral-reef formation, we must be always prepared for the occurrence of special cases which can only be accounted for by the operation of exceptional causes. The full and complete account—which will no doubt be sufficiently illustrated—of Prof. W. M. Davis's important series of explorations will be looked forward to with special interest, and in the meantime the subjoined general summary of his results will be welcomed by all naturalists.

J. W. J.

Preliminary Report on a Shaler Memorial Study of Coral Reefs.

A liberal grant from the Shaler Memorial Fund of Harvard University, supplemented by a generous subsidy from the British Association for the Advancement of Science, with an invitation to attend its meeting in Australia last August as a foreign guest, enabled me to spend the greater part of the year 1914 in visiting a number of islands in the Pacific Ocean with the object of testing various theories that have been invented to account for coral reefs. Thirty-five islands, namely, Oahu in Hawaii, eighteen of the Fiji group, New Caledonia, of which the entire coast-line was traced, the three Loyalty islands, five of the New Hebrides, Raratonga in the Cook group, and six of the Society islands, as well as a long stretch of the Queensland coast inside of the Great Barrier reef, of north-eastern Australia, were examined in greater or less detail. A brief statement of my results has been published in the Proceedings of the National Academy of Sciences for March, 1915. A full report upon my observations will appear later, probably in the Bulletin of the Museum of Comparative Zoology at Harvard College. The general conclusions reached are here briefly summarised.

Any one of the eight or nine theories of coral reefs will satisfactorily account for the visible features of sea-level reefs themselves, provided the postulated conditions and processes of the invisible past are accepted; hence a study of the visible features of the reefs alone cannot lead to any valid conclusions. Some independent witnesses must be interrogated, in the hope of detecting the true theory of their origin. The only witnesses, apart from sections obtained by deep and expensive borings, available for sea-level reefs are the central islands within oceanic barrier reefs, or the mainland coast within a continental barrier reef. The testimony of these witnesses has been too largely neglected, apparently because most investigators of coral reefs have been zoologists, little trained in the physiography of shore lines. Elevated reefs afford additional testimony in their structure and in the relation of their mass to its foundation; but this testimony also has been insufficiently considered, perhaps because most investigators of reefs have as zoologists been little trained in structural geology; hence it seemed desirable to give as much time as possible on the Pacific Islands to questioning the independent witnesses above designated.

The testimony of the first group of witnesses—the central islands of barrier reefs—convinced me that Darwin's theory of subsidence is the only theory competent to explain not only the development of barrier reefs from fringing reefs, but also the shore-line features of the central islands within such reefs; for the embayments of the central islands testify emphatically to subsidence, as Dana long ago pointed out; thus my results in the study of this old problem of the Pacific agree with those of several other recent students, especially Andrews, Hedley, and Taylor of Australia, and Marshall of New Zealand. Darwin's theory of subsidence also gives by far the most probable explanation of atolls; for it is unreasonable to suppose that a subsidence of the ocean bottom should occur only in regions where the central islands of barrier reefs are present to attest it, and not in neighbouring regions where reefs of identical appearance, but without a central island, are given another name.

The testimony of the second group of witnesses—massive elevated reefs such as occur on certain Fiji islands—convinced me that Darwin's theory of subsidence gives the only satisfactory explanation of the origin of such reefs also; for their limestones rest unconformably on the normally eroded surface of a pre-existent foundation. The erosion of the foundation surface shows that it stood above sea-level before the reef was deposited upon it; and the occurrence of the reef shows that the eroded foundation subsided to receive its marine cover. Only after this subsidence was the compound mass uplifted. The mere occurrence of elevated reefs above sea-level does not for a moment prove that they were formed during the emergence of their foundation.

All the still-stand theories of barrier reefs—that is, all the theories which involve a fixed relation of the reef foundation to the sea-level during the formation of the reef mass—are excluded by evidence of submergence found in the embayed shore lines of the central islands within barrier reefs. It may seem over-bold thus at a stroke to set aside several well-known theories, accepted by experienced observers; and so indeed it would be if these observers had discussed the features of the embayed central islands, and had explicitly shown that their embayments are not due to submergence but to some other cause. It is, however, a regrettable fact that the observers who adopted one or another of the still-stand theories took, like Darwin himself, practically no account of the embayed central islands, essential as the testimony of these islands is in the solution of the coral-reef problem. Such neglect is all the more remarkable in view of the clear statement, long ago published by Dana, regarding the pertinence and the value of the testimony afforded by the central islands of barrier reefs.

The glacial-control theory of coral reefs, recently elaborated by Daly with special reference to the lagoons of atolls, will not hold for barrier reefs. This theory assumes that no subsidence of the reef-foundations took place, and explains the lagoon floors of atolls as platforms abraded across pre-glacial sea-level reef-masses by the lowered and chilled sea of the glacial period after the corals were killed; the pre-glacial reef-masses having been formed by upward or outward growth on still-standing foundations. It then explains the encircling reefs which now surround the lagoons as having been built up while the sea was rising and warming in post-glacial time. But if the broad lagoons of large atolls twenty or thirty miles in diameter were thus formed, the central islands within narrow-lagoon barrier reefs should be cliffed all around their shore line, and they are not. Furthermore, this theory explains the embayments of central islands within barrier reefs as occupying new-cut valleys that were eroded during the glacial period of lowered sea-level; but if this were the case, the new-cut valleys should be prolonged upstream from the embayment heads as incisions in the floors of pre-glacial valleys, thus producing a "valley-in-valley" landscape; and this is not true in any one of the hundreds of embayments seen during the past year. Furthermore, many of the embayments are so wide that, if they were opened by slow subaerial processes, the spur-ends ought to have been well cliffed by the sea; yet, as above stated, they are not cliffed. Finally, many of the embayments are too wide to have been eroded during the last glacial epoch, or even during all the glacial epochs of the entire glacial period, if the valleys of the formerly glaciated volcanoes in central France are taken as standards of the amount of erosion that could be accomplished on such masses during such intervals of time. The glacial control theory thus proves incompetent to explain barrier reefs, and it is therefore held to be generally incompetent to explain atolls also; it may have more importance on the borders of the coral zone, where the corals would most likely have been killed during the glacial period: the Marquesas islands promise interesting results in this connection. The glacial-control theory has its greatest importance in conjunction with Darwin's theory of subsidence; for submergence during subsidence may have been almost neutralised by the lowering of the sea-level during the oncoming of a glacial epoch, and under such conditions coral reefs would broaden and lagoons would become shallow; but with the passing of a glacial epoch the return of ice-sheet water to the ocean would accelerate the submergence due to subsidence, and at such a time, coral reefs might be more or less completely drowned; thus the discontinuity of certain reefs on so-called "platforms" may be explained.

All the phenomena which testify to the formation of coral reefs on subsiding foundations can be equally well explained by the assumption of a rise of the ocean surface around or over fixed foundations; but a rise of the ocean surface in any coral-reef region demands a rise of the whole ocean surface; and if the coral-reef foundations are to stand still, a rise of the whole ocean surface can be explained only as the diminished result of a greater rise of the ocean floor in some non-coral-reef region. The conditions involved in this alternative for the simple theory of local subsidence are so extravagantly improbable that, as soon as they are explicitly defined, they must be rejected.

No absolute demonstration of the origin of coral reefs, or, for that matter, of any other geological structure, is possible; the most that can be hoped for is a highly probable conclusion. The conclusions announced above in favour of Darwin's theory are believed to have about the same order of probability as that usually accepted as "proof" in geological discussions.

A number of local conclusions may be briefly announced as follows:—

The elevated reef along the south coast of Oahu, Hawaii, was formed during or after a sub-recent period of subsidence, for its limestones enter well-defined valleys that must have been eroded when the island stood higher than now, and before the reef-limestones were deposited in them.

The Fiji group has suffered various movements of subsidence and elevation by which its many islands were affected in unlike ways. Elevation has taken place at different times in different islands, for some of the elevated reefs are elaborately dissected, others are very little dissected, and still others remain at sea-level. The embayments due to the latest submergence of the larger islands, Viti Levu and Vanua Levu, are now largely filled with delta plains. All the reefs, those now elevated as well as those at sea-level, appear to have been formed during periods of subsidence; the evidence afforded by the elevated reefs of Vanua Mbalavu, Mango, and Thithia is specially significant on this point. The medium-sized island of Taviuni has few visible reefs, because its flanks and shores are flooded by sheets of recent lava. The small island of Wakaya seems to be a tilted block of lava beds, not a dissected volcano.

The extensive barrier reef of New Caledonia has grown up during a recent subsidence by which that long and maturely dissected island has been much reduced in size and elaborately embayed; but unlike most encircled islands, this one was strongly cliffed around its south-eastern end, and along much of its north-eastern side before the recent subsidence took place.

The two south-eastern members of the Loyalty group, Maré and Lifu, are former atolls, evenly uplifted about 300 ft.; Maré shows a small hill of volcanic rock in the centre of its limestone plateau or elevated lagoon floor. Uvea, the north-western of the three Loyalty islands, is a slightly tilted atoll; its eastern side shows an uplifted reef in rudely crescentic form, which reaches a height of 100 or 200 ft. at the middle of its crescent, and slowly descends to sea-level at its horns; a bight in its convex front may be the result of a landslide; the tilted lagoon floor slowly deepens westward and is enclosed by disconnected, upbuilt reef-islands.

The New Hebrides show signs of uplift in their elevated reefs, and of depression in their embayments. There is some evidence that certain uplifted fringing reefs on the island of Efaté, near the centre of the group, were formed during pauses in a subsidence that preceded their uplift, and not during pauses in their uplift as inferred by Mawson. The narrowness of the lagoons enclosed by the barrier reefs that encircle certain strongly embayed islands in this group may be explained by supposing alternations of slow and rapid subsidence; thus the earlier-formed reefs, which began to grow when the subsidence was slowly initiated, were drowned when it was later accelerated; and new reefs, thereupon begun on the shore line of that time, now, after a second period of slow subsidence, stand near the present shore line, though the shore line is strongly embayed, because the total subsidence has been large. The absence of reefs around the island of Ambrym is due to its abundant eruptions in recent time, the latest one being in December, 1913; scattered corals were seen growing on one of its sea-cliffed lava-streams, thus illustrating the initial stage of a fringing reef.

The Great Barrier reef of Australia, the greatest reef in the world, with a length of some 1200 miles and a lagoon from 15 to 70 or more miles wide, has grown upward during the recent subsidence by which the Queensland coast has, after a long period of still-stand, been elaborately embayed, as was pointed out by Andrews in 1902. A very recent uplift of some 10 ft. has occurred, as was long ago noted by Jukes. There is much reason for believing that a broadened reef-plain, with extensive land-fed deltas along the continental margin, had been formed before the recent subsidence took place; and it is this broadened reef, now submerged, that is thought to form the "platform" on which the Great Barrier reef has grown up. Guppy's suggestion that the platform or "submarine ledge" is due to marine abrasion, before coral reefs were established here, and that no subsidence has taken place, cannot be accepted. It is highly probable that the well-attested recent subsidence was due to a gentle flexure, by which the offshore sea-bottom was bent down; and, if so, the coastal submergence will give too small a measure of the thickness of the distant barrier reef. In this respect the Great Barrier reef along the shore of a continent differs significantly from smaller barrier reefs around oceanic islands, in which the subsidence of the island and its reefs are essentially uniform.

A few hours on shore at Raratonga, the southernmost member of the Cook group, sufficed to show that extensive embayments formerly entering its elaborately carved mass are now occupied by delta plains and perhaps in part by slightly elevated reef-and lagoon-limestone.

Five islands of the Society group exhibit signs of recent subsidence in their intricately embayed shore lines, as has lately been announced by Marshall. A sixth, the cliff-rimmed island of Tahiti, the largest and youngest of the group, suffered moderate subsidence after its cliffs were cut, but the resulting bays are now nearly all filled with delta plains, which often advance into the narrow lagoon; hence a pause or still-stand has followed its latest subsidence. All the barrier reefs of this group appear to have been formed during the recent subsidence that embayed their central islands.

W. M. Davis.

FORMULAS FOR GLASS MANUFACTURE.

THE Institute of Chemistry has sent us an account of the work of the Glass Research Committee appointed by the council of the institute in October last to conduct investigations with the view of arriving at suitable formulas for laboratory glassware, miners' lamp-glasses, combustion tubing, resistant glass for pharmaceutical products, glass for X-ray bulbs, etc. The main part of the report is here reprinted, and is of particular interest at the present time. Copies of the formulas can be obtained from the secretary, Institute of Chemistry, 30 Russell Square, W.C.

Since October, 1914, the research has been continued uninterruptedly, the chief aims being:—(i) to produce working formulas for all glasses used in laboratory work, and (ii) to ascertain the influence of various ingredients on the physical and chemical properties of glasses. The work was extended to include glass for miners' lamp-glasses, at the suggestion of the Home Office; and also glass for ampoules, to meet the needs of wholesale pharmaceutical chemists engaged in the production of army medical requirements. The committee also examined and reported on samples of British and French laboratory glassware, produced since the beginning of the war, a number of the specimens being made from formulas similar to, and in some cases almost identical with, those recommended by the committee.

The committee has had before it many specimens of glasses used for various purposes, of which analyses have been made by Mr. Bertram Blount, Mr. W. C. Hancock, and Mr. Otto Hehner. It has been found, however, that mixtures prepared in accordance with the analytical results were not always satisfactory; but the analyses were helpful in suggesting synthetic experiments, and during recent investigations some intricate analyses made by Mr. G. J. Alderton under the supervision of Mr. Blount have proved especially valuable. Apart from the analyses, the work has been almost entirely carried on at King's College by Prof. Herbert Jackson and Mr. T. R. Merton, and by the former at his own house. The work has involved a careful study of the chemistry of silicates, aluminates, borates, etc., in their relation to the manufacture of glasses.

Up to the present time, the research committee has reported eleven formulas for glasses for various purposes based on the results of about 400 experimental melts on a scale large enough for drawing rods and blowing small vessels. In addition, a very great number of experiments have been made in order to study the influence of the various constituents employed. No formula has been issued without submitting the specimens made to rigorous tests to prove their suitability for the purposes for which they are intended. Moreover, by varying the experimental working conditions, it can be said with reasonable confidence that the mixtures will prove equally satisfactory under the actual working conditions of a glass furnace. The question of workable temperatures has been carefully considered, and, so far as it is possible to judge, the melts on a small scale indicate that even better results will be obtained on the industrial scale. This view has been justified by the samples already received from manufacturers who have tried some of the formulas.

In deciding the formulas it has been found necessary to direct special attention to the proportions of basic and acidic substances in respect of the action of glass mixtures on clay crucibles during fusion, and it has been shown by careful investigation that the formulas proposed give melts in which the influence of the ingredients of the crucibles is very slight and in some cases practically inappreciable.

The following formulas have been communicated to a number of manufacturers who have expressed their interest in the progress of the investigation and to scientific workers who are conducting similar experiments.

Soft glasses, suitable for ordinary chemical laboratory ware.

	Parts		Parts
(1) Sand	67·0	Calcium carbonate	11·6
Sodium carbonate (Na_2CO_3) ...	34·2	Alumina (Al_2O_3)	6·5

A soft glass which does not give up alkali readily to water, works well in the blowpipe, and does not devitrify readily.

	Parts		Parts
(2) Sand	67·0	Calcium fluoride	1·6
Sodium carbonate (Na_2CO_3) ...	29·0	Alumina (Al_2O_3)	8·3
Calcium carbonate	9·6	Boric anhydride (B_2O_3) ...	2·0

A soft glass of higher quality. Does not give up alkali under severe tests. A kindly working glass before the blowpipe, and very difficult to devitrify.

A resistant glass suitable for pharmaceutical purposes, ampoules, etc.

	Parts		Parts
(3) Sand	67·0	Potassium nitrate	1·0
Alumina (Al_2O_3)	10·0	Sodium carbonate (Na_2CO_3) ...	17·0
Calcium carbonate	12·5	Boric anhydride (B_2O_3) ...	8·0
Magnesia ...	0·5		

This glass is intermediate in hardness between soft glass and combustion tubing, is highly resistant to chemical action, withstands changes of temperature well, and should be a very suitable glass for high-class beakers, flasks, etc.

Glasses for combustion tubing.

	Parts		Parts
(4) Sand	68·2	Sodium carbonate (Na_2CO_3) ...	5·5
Alumina (Al_2O_3)	6·2	Boric anhydride (B_2O_3) ...	5·5
Barium carbonate	8·8	Calcium fluoride	1·0
Calcium carbonate	13·0		
Potassium nitrate	4·3		

This glass resembles Jena combustion tubing very closely indeed. It has practically the same fusing point. It fuses on to Jena glass perfectly, and is indistinguishable from it before the blowpipe and in its behaviour on prolonged heating below its fusing point. The presence of the small quantity of calcium fluoride facilitates the incorporation of the ingredients. The sodium carbonate can be reduced to 1·34 parts provided 7·93 parts of anhydrous borax be used in the place of boric anhydride.

	Parts		Parts
(5) Sand	68·2	Sodium carbonate (Na_2CO_3) ...	5·5
Alumina (Al_2O_3)	6·2	Boric anhydride (B_2O_3) ...	5·5
Barium carbonate	8·8		
Calcium carbonate	14·2		
Potassium nitrate	4·3		

This glass is practically of the same composition as (4). It is not so easy to make or to work, but it does not become so opaque as Jena combustion tubing on prolonged heating. As in No. (4), the proportions given for sodium carbonate and anhydrous borax can be substituted for the figures for sodium carbonate and boric anhydride.

Miners' lamp glasses.

	Parts		Parts
(6) Sand	65·0	Potassium nitrate	3·0
Alumina (Al_2O_3)	1·0	Sodium carbonate (Na_2CO_3) ...	14·0
Calcium carbonate	0·6	Boric anhydride (B_2O_3) ...	24·0
Arsenious oxide (As_2O_3) ...	2·0		
Antimony oxide (Sb_2O_3) ...	1·0		

A colourless and fusible glass withstanding rapid changes of temperature exceptionally well.

	Parts		Parts
(7) Sand	65·0	Potassium nitrate	3·0
Alumina (Al_2O_3)	1·0	Anhydrous borax ($Na_2B_4O_7$) ...	26·68
Calcium carbonate	0·6	Boric anhydride (B_2O_3) ...	5·5
Arsenious oxide (As_2O_3) ...	2·0		
Antimony oxide (Sb_2O_3) ...	1·0		

The same glass as (6), but the ingredients have been varied to avoid the use of so much boric anhydride, which is at present apparently difficult to obtain on a commercial scale.

Resistance-glass.

	Parts		Parts
(8) Sand	65·5	Sodium carbonate (Na_2CO_3) ...	10·2
Alumina (Al_2O_3)	2·5	Borax anhydrous ($Na_2B_4O_7$) ...	13·0
Magnesia (MgO)	5·0		
Zinc oxide (ZnO)	8·0		

A glass almost identical in its general behaviour with Jena resistance glass; withstands changes of temperature well, but, like Jena, is not suitable for working before the blowpipe. It darkens and tends to devitrify; operations—such, for instance, as sealing side tubes into flasks—are difficult, if permanent and neat joints are required.

Formula No. 3, recommended for pharmaceutical purposes, ampoules, etc., may be substituted for the resistance glass with advantage, as the ampoule glass lends itself very well to blowpipe work, and is also especially resistant chemically.

Alternative for combustion tubing.

	Parts		Parts
(9) Sand	72·0	Potassium nitrate (KNO_3) ...	3·0
Alumina (Al_2O_3)	10·0	Sodium carbonate (Na_2CO_3) ...	11·2
Calcium carbonate	11·0	Borax anhydrous ($Na_2B_4O_7$) ...	7·2
Magnesia (MgO)	0·5		

This glass is capable of withstanding high temperatures and rapid changes of temperature; works well before the blowpipe, and is free from the chief defect of Jena glass—namely, the readiness with which it becomes cloudy, and finally quite opaque after prolonged use.

By slight modifications of this formula, almost any degree of hardness can be obtained.

In formulas (8) and (9) substances such as magnesia (MgO) and zinc oxide (ZnO) can be added in the form of carbonates if the actual percentages of MgO and ZnO respectively present in the carbonates are known.

Soft soda-glasses suitable for tubing and for X-ray bulbs.

	Parts		Parts
(10) Sand	68·0	Potassium nitrate (KNO_3) ...	14·5
Alumina (Al_2O_3)	4·0	Sodium carbonate (Na_2CO_3) ...	26·0
Calcium carbonate ($CaCO_3$)	12·8		

	Parts		Parts
(11) Sand	68·0	Potassium carbonate (K_2CO_3)	10·0
Alumina (Al_2O_3)	4·0	Sodium carbonate (Na_2CO_3)	26·0
Calcium carbonate	12·8		

These glasses do not lose their easy-working qualities after repeated heating and blowing, and are plastic over a long range of temperature. They require a temperature of at least 1400–1500° C. for complete incorporation of the ingredients in order to obtain that homogeneity which is necessary for resistance to rapid changes of temperature and ease of working before the blowpipe.

No. (10), containing potassium nitrate, is considered the better of the two, and is more easily incorporated.

The committee considers that the formulas obtained and the work done on the various glasses justify it in the opinion that there is now information available for the manufacture of all the important glasses used in the laboratory and for industrial purposes, which have hitherto been mainly obtained from abroad.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Prof. T. G. Brodie, professor of physiology in the University of Toronto, will deliver a course of four lectures on "The Gases of the Blood" at King's College, London, on May 31, June 2, 7, and 9. These lectures take the place of those previously announced; they are free to medical students, to internal students of the University, and to medical men on presentation of their cards.

MR. A. G. R. FOULERTON has been appointed lecturer in public health at the London (Royal Free Hospital) School of Medicine for Women, in succession to Prof. W. J. Simpson, resigned.

THE Education Committee of the County Council of the West Riding of Yorkshire has arranged a summer vacation course for teachers, which is to be held at Bingley Training College from August 4 to 18 next. Four evening lectures will be given during the course, including one by Mr. Mackinder on how much geography and history can be taught within the limits of the elementary school. The general course makes provision among numerous other subjects for lectures on the teaching of informal domestic work in schools, and the special courses include lectures on animal and plant life. The primary object of the courses is to increase the educational spirit and efficiency of persons teaching in the West Riding, and to enable them to supplement their knowledge of the various subjects, and of the most approved methods of teaching them. All particulars of the course, including time-tables, are given in the "Bingley Vacation Course Syllabus," copies of which may be obtained on application to the Education Department, County Hall, Wakefield.

ON March 6, Lord Hardinge, Viceroy of India, presided over the annual convocation of Calcutta University, and delivered an address in his capacity of Chancellor of the University. The address is printed in the issue of the *Pioneer Mail* for March 12. The Chancellor referred to the increased interest which has arisen in Indian universities in the teaching of science subjects. University inspection combined with an ordered procedure in affiliation has considerably raised the standard of instruction in the colleges. Some of the laboratories attached to these institutions can now compare favourably with any in the world. The teaching staffs have been strengthened. The advanced students produce papers dealing with subjects of research which are accepted by leading scientific journals in Europe. In the past years the Government of India has contributed generously to the capital requirement of the University of Calcutta, which also draws an annual sum, the capitalised value of which is 36½ lakhs, and generous gifts have been received recently from the late Sir Taraknath Palit and Dr. Rashbehari Ghosh. In Bombay the contributions of few public-minded citizens to the proposed Royal Institute of Science have totalled nearly 25 lakhs, while Sir Chinubhai Madhav Lal has endowed the Institute of Science of Ahmedabad with six lakhs, giving a further two lakhs to the Gujerat College, with which it is associated. Lord Hardinge also dealt with the question of university buildings and libraries The universities of India have recently made laudable efforts, which have been substantially aided by the Government, to provide for themselves local habitations in the shape of buildings befitting their dignity, and libraries where their alumni may learn the use of books and the methods of investigation and research which collections of books alone make possible. Calcutta has not been behindhand. Thanks to the generosity of the Maharaja of Darbhanga, the University is now possessed of a handsome library. The students of the Law College are accommodated in a hostel towards which the Government contributed three lakhs. The Government has also made a grant of eight lakhs for the purchase of a valuable site which abuts on the University buildings, and the acquisition of which should permit of further extension.

SOCIETIES AND ACADEMIES.

London.

Physical Society, March 26.—Dr. A. Russell, vice-president, in the chair.—Prof. A. W. **Porter** and F. **Simeon**: The change of thermal conductivity with fusion. The change in question was determined for mercury and for sodium by finding the temperatures at different points of a cylinder of the metal contained in a glass tube. The ends of the cylinder were maintained at such temperatures that the metal was liquid half-way down its length, the remaining part being solid. The temperatures were taken by means of thermo-electric junctions inserted in narrow tubular depressions which had been formed in the glass tube by forcing a knitting needle down into the locally heated glass. The ratio of the thermal conductivity for solid and liquid was estimated from the slope of tangents drawn to the temperature-curve on each side of the melting point. The values of these ratios are of the same order as the ratio of the corresponding values of the electrical conductivities. The mean value for mercury is 3·91, and for sodium 1·31.—Dr. J. A. **Fleming**: An instrument for the optical delineation and projection of physical curves such as hysteresis, resonance, and characteristic curves. This instrument is designed for projecting on to a screen or photographing on a plate such curves as magnetic hysteresis, resonance, or characteristic curves which can be performed slowly, or are non-periodic or non-repetitive.—Dr. P. **Phillips** and J. Rose **Innes**: The stability of some liquid films. The authors give a simple method of calculating the equilibrium form of a thin film which is a surface of revolution. They then consider the stability for certain kinds of displacement of three classes of such films, viz., the sphere, the cylinder and the catenoid. The mathematics used is quite elementary throughout and the treatment is rigorous.—Prof. A. W. **Porter** and E. Talbot **Paris**: A demonstration of the green-flash of the setting of an artificial sun. A large disc of card mounted so that it can be slowly rotated has a hole, 1 in. in diameter, cut in it about 2 in. from the periphery. This is covered with red gelatine films, and is illuminated from behind so as to form an artificial sun. The front of the disc is covered with white Bristol board and is moderately illuminated by a lamp in front. This sun is viewed through a rectangular aperture (4 in. wide) in a blackened board, the lower edge of the aperture serving as the horion. When the disc is rotated the artificial sun sets and green after-images are obtained of characters varying according to the amount that the eye has been exposed to the bright sun. If the sun is not viewed until immediately before the complete setting the after-image represents simply the disappearing segment to which it is due. The authors claim that this phenomenon is what is often described as the green-flash at sunset, though they are ready to admit that other (but probably rarer) phenomena also go under the same name.

Manchester.

Literary and Philosophical Society, March 23.—Mr. F. Nicholson, president, in the chair.—T. A. **Coward**: A note on the behaviour of a blackbird—a problem in mental development. The author referred to the habit of certain birds—individual, not specific—which when stirred by spring rivalry will fight with their own reflections as seen in windows, and spoke, in particular, of a male blackbird which for more than a month has been daily assaulting its own image in a particular window. A blackbird, presumably the same, behaved in a similar way at the same window all through last spring. Attention was directed to the psychological problem presented by a bird with an excellent memory but without any apparent power of learning by experience. The recollection of this visionary antagonist was stimulated by the seasonal sexual activity and died down with the normal waning of this force.—A. W. Rymer **Roberts**: Two cases of parallelism in the Aphidæ. Parallel series of aphids may co-exist on the same or on different plants, having the same ancestry but differing in habits and sometimes also in form. The phenomenon was first brought in prominence by Cholodkovsky's recent researches on Chermes. Though there exists some doubt, in the light of more recent research, whether the instances principally relied upon are not those of distinct biological species, other instances have been discovered of as many as four parallel forms being descended from the winter-form on the secondary host-plant in certain species of Chermes. Parallelism exists also in other groups, as in the Pemphiginæ, two instances observed being (1) *Thecabius affinis*, a species migrating between poplars and Ranunculus, and (2) *Hamamelistes tullgreni*, so far only found on birch. *T. affinis* has been found continuing to live over the winter on Ranunculus after the migrating individuals have returned to the poplar. *H. tullgreni* has been observed in England for the first time during the past year. Certain of its forms resemble scale insects. It has so far only been found upon birch, but winged individuals fly from that to some other plant, leaving wingless individuals to continue the race on the birch, both being descended from a single ancestress by parthenogenesis.

Edinburgh.

Royal Society, March 1.—Prof. Hudson Beare, vice-president, in the chair.—H. **Levy**: The resistance of a fluid to a body moving through it. In this paper it was shown that trails of vortices following in the wake of a body moving through a fluid did not form a stable system, so that the theory recently advanced by Karman, which was based upon a suggestion made originally by Kelvin, did not seem to be tenable. The paper also contained an interesting development of the method of finding the stream lines with certain definable forms of boundary.—F. D. **Miles**: The electrical conductivity of aqueous hydrochloric acid, saturated with sodium chloride; and on a new form of conductivity cell. Within the range of concentration (15 to 27 per cent. of hydrogen chloride) the specific conductivity is lowered by saturation with salt. The salt-saturated acid of maximum conductivity was prepared by adding salt to a solution containing 21·9 per cent. of hydrogen chloride, whereas the best conducting solution of hydrogen chloride alone contains only 19·1 per cent. of that substance. The conductivity cell described was specially suitable for solutions which are saturated or contain volatile constituents.—F. D. **Miles**: The reaction between sodamide and hydrogen. At temperatures near to 250° C. these substances react according to the formula, $NaNH_2 + H_2 = NaH + NH_3$.

March 15.—Prof. Bower, vice-president, in the chair.—Dr. J. H. **Ashworth**: The larvæ of Lingula and Pelagodiscus. Sixteen larvæ of *Lingula anatina* were taken by him last year in the surface waters of the southern part of the Red Sea, and one in the Indian Ocean about 4° south of Colombo. The latter is noteworthy because of the depth of water (2200 fathoms) in the locality where the larva was taken. The larvæ varied from 0·5 to 1·6 mm. in length. Descriptions were given of the alimentary canal, calomoducts (nephridia), and statocysts, and of the changes in shape of the shell valves as growth proceeds. An account was also given of the anatomy of the larva of *Pelagodiscus* (*Discinisca*) *atlanticus*, based on six specimens, about 0·4 mm. in length, which were taken in October last a few miles west of Cape Cormorin in water of 40 fathoms. Adult specimens of this Brachiopod have almost entirely been recorded from deep water. Blochmann has denied the presence of statocysts in both Lingula and Pelagodiscus, but these organs were certainly present in both genera.—C. **Cochrane**: The reflective power of pigments in the ultra-violet. The diffuse reflection from the prepared strip of pigment, which was illuminated by a complete iron-arc spectrum, was photographed, a similar photograph of the reflection from a contiguous strip of white cardboard being simultaneously taken as a standard of comparison. More than thirty different pigments were experimented with, and of these the greater number showed selective reflection in the higher ultra-violet. There were, however, marked exceptions, such as Chinese white, the reflective power of which rapidly diminished as the wave-lengths became shorter.—Dr. W. T. **Gordon**: Archæocyathinæ collected by the Scottish National Antarctic Expedition. The specimens were obtained in a block of limestone dredged in the Weddell Sea, and associated with them were remains of calcareous algæ and sponges. The Archæocyathinæ can be grouped under the genera Archæocyathus, Spirocyathus, Coscinocyathus, Syringocnema, and Protopharetra. The fauna shows striking similarity with that described by Taylor from the Cambrian rocks of South Australia.

Paris.

Academy of Sciences, April 6.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The instrumental undulations of images; their daily and annual variation and their relation with the general state of the atmosphere. A discussion of the causes and means of elimination of the irregular movements of the focal images of stars.—Paul **Appell**: The approximate inversion of certain real integrals, and on the extension of Kepler's equation and Bessel's functions.—L. E. **Bertin**: Calculation of the increase of velocity or of range of submarines resulting from increase of their dimensions. Data furnished by ordinary vessels are not directly applicable to submarines. It would appear that the maximum speed and range will be reached for a submarine having a displacement at the surface of 1000 tons.—Maurice **Hamy**: Radiography in the hospital at the Institute. Radiographs of all the wounded are made as they enter the hospital in the same attitude on two distinct plates, the bulb being moved a distance of 7 cm. The negatives, examined in a specially constructed stereoscope, show the position of the metallic fragment or damaged bone in relief, by means of which the operation is much simplified.—M. **Guignard**: The formation of pollen.—J. **Bosler**: The rotation of the solar corona. Measurements of the red line of wavelength 6374·4 on the east and west borders gave by the application of the Doppler-Fizeau principle a tangential velocity of 3·7 kilometres per second, with a possible error of 25 to 30 per cent. This agrees well with the determination of W. W. Campbell, who by applying the same method to the green line 5303 obtained a velocity of 3·1 kilometres per second. Hence the corona moves in the same sense as the direction of movement of the sun, and apparently with a higher velocity.—H. **Deslandres**: Remarks on the preceding communication and on problems connected with the rotation of the solar corona. The study of the corona throws light on the important question of a corpuscular radiation emitted by the sun and received by the earth, but increase of knowledge in this direction must necessarily be slow, since the corona is only observable during eclipses.—Daniel **Berthelot**: The temperature-coefficient of photochemical reactions. For the changes studied, the decomposition of lævulose and the decomposition of a mixture of oxalic acid and ferric chloride the rate of photochemical change is increased by a rise of temperature, but the coefficient is very much smaller than that of an ordinary chemical change.—Henri **Coupin**: The resistance of marine bacteria to the action of salt. Marine bacteria have tolerance for a considerable range in the proportion of salt in the water in which they develop, as they can support 8 per cent., and are content with as little as 0·3 to 0·2 per cent. They adapt themselves better to proportions lower than the normal sea-water salt-content than to more concentrated solutions.—C. **Sauvageau**: The development and the biology of *Saccorhiza bulbosa*.—J. **Bergonié**: The detection and localisation of magnetic projectiles by an electromagnet actuated by an alternating current. The vibration of the flesh immediately over the metallic fragment gives an accurate indication of its position. Details are appended of several operations successfully carried out by this means.—MM. **Belot** and Maxime **Ménard**: The use of the Coolidge tube in the medico-surgical applications of the X-rays. The Coolidge tube is based on the discharge of independent electrons and details are given of a pattern made in France by Pilon. The advantages obtained, as compared with the ordinary tube, are the regularity in working, the long period of regular working, the possibility of regulating the tube without modifying the vacuum, the fixed point of impact on the kathode, and the homogeneity of the bundle of X-rays.—Miramond **de Laroquette** and Gaston **Lemaire**: Tables of the coefficients of magnification of radiographic images utilisable for the localisation of projectiles in the tissues.—Pierre Delbet and H. Vaquez: Chondrectomy in certain irreducible dilatations of the right heart.

BOOKS RECEIVED.

British Museum (Natural History). Report on Cetacea Stranded on the British Coasts during 1914. Pp. 16. (London: British Museum (Natural History); Longmans and Co.) 1s. 6d.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. i., No. 2. Natural History of the Adelie Penguin. By Staff-Surgeon G. Murray Levick. Pp. 55–84+plates i–xxi. (London: British Museum (Natural History); Longmans and Co.) 5s.

Memoir on the Economic Geology of Navanagar State in the Province of Kathiawar, India. By E. H. Adye. Pp. xxvi+262. (Bombay: Thacker and Co., Ltd.)

The Manchester Museum. Museum Handbooks: The Stela of Sebek-khu. By T. E. Peet. Pp. 21. (Manchester: University Press.) 2s.

The Plateau Peoples of South America. By A. A. Adams. Pp. 134. (London: G. Routledge and Sons, Ltd.) 3s. 6d. net.

An Amateur's Introduction to Crystallography. By Sir W. P. Beale. Pp. vii+220. (London: Longmans and Co.) 4s. 6d. net.

The Panama Canal. By R. E. Bakenhus, Capt. H. S. Knapp, and Dr. E. R. Johnson. Pp. xi+257. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 10s. 6d. net.

Heating and Ventilating Buildings. By Prof. R. C. Carpenter. Sixth edition. Pp. xiv+598. (New York: J. Wiley and Sons, Inc.: London: Chapman and Hall, Ltd.) 15s. net.

DIARY OF SOCIETIES.

THURSDAY, April 15.

Royal Institution, at 3.—The System of the Stars: Star Colour and its Significance: Prof. A. S. Eddington.

Institution of Electrical Engineers, at 8.—The Power Supply of the Central Mining-Rand Mines Group: J. H. Rider.

Linnean Society, at 5.—Experiments and Observations bearing on the Interpretation of Form and Coloration in Plants and Animals: C. F. M. Swynnerton.

Institution of Mining and Metallurgy, at 8.—The Precipitating Action of Carbon in Contact with Auriferous Cyanide Solutions: W. R. Feldtmann.—Cyaniding of Gold-Silver Ores at Waihi Grand Junction: N. Carless.—The Effect of Mineralised Waters in Cyanide Plants: T. B. Stevens and W. S. Bradley.

FRIDAY, April 16.

Royal Institution, at 9.—The Russian Idea: S. Graham.

Institution of Mechanical Engineers, at 8.—President's address: Dr. W. Cawthorne Unwin.

SATURDAY, April 17.

Royal Institution, at 3.—Modern Artillery: Lieut.-Col. A. G. Hadcock.

MONDAY, April 19.

Victoria Institute, at 4.30.—The Zoroastrian Doctrine of a Future Life: Prof. J. Hope Moulton.

TUESDAY, April 20.

Röntgen Society, at 8.15.—Late Radium and X-Ray Burns: Dr. N. S. Finzi.—A New Alpha Ray Effect: F. H. Glew.

Royal Statistical Society, at 5.15.—The Progress of Friendly Societies and other Provident Institutions during the Ten Years 1904–1914: Sir Edward Brabrook.

Wireless Society, at 8.—Methods of the Measurement of the Strength of Wireless Signals: Dr. E. W. Marchant.

WEDNESDAY, April 21.

Royal Meteorological Society, at 7.30.—A Study of the Moving Waves of Weather in South America: H. Helm Clayton.—The Correlation between Changes in Barometric Height at Stations in the British Isles: E. H. Chapman.

THURSDAY, April 22.

Royal Society, at 4.30.—*Probable Papers:* Deep Water Waves, Progressive or Stationary, to the Third Order of Approximation: Lord Rayleigh.—A Chemically Active Modification of Nitrogen, produced by the Electric Discharge. VI.: Hon. R. J. Strutt.—The Difference between the Magnetic Diurnal Variations on Ordinary and Quiet Days at Kew Observatory: Dr. C. Chree.—The Effects of Different Gases on the Electron Emission from Glowing Solids: F. Horton.—Heats of Dilution of Concentrated Solutions: W. S. Tucker.—The Origin of the "4686" Series: T. R. Merton.

Royal Institution, at 3.—The System of the Stars: The Stellar System in Motion: Prof. A. S. Eddington.

FRIDAY, April 23.

Royal Institution, at 9.—Military Hygiene and the War: Major P. S. Lelean.

Institution of Mechanical Engineers, at 8.

Physical Society, at 5.—The Theories of Voigt and Everett Regarding the Origin of Combination Tones. Prof. W. B. Morton and Miss Mary Darragh.—Experiments on Condensation Nuclei Produced in Gases by Ultra-Violet Light: Miss Maud Saltmarsh.—The Self-Induction of Solenoids of Appreciable Winding Depth: S. Butterworth.

SATURDAY, April 24.

Royal Institution, at 3.—Modern Artillery: Lieut.-Col. A. G. Hadcock.

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THURSDAY, APRIL 22, 1915.

THE BIOLOGICAL PROBLEM OF SEX.

The Determination of Sex. By Dr. L. Doncaster. Pp. x + 172. (Cambridge: At the University Press, 1914.) Price 7s. 6d. net.

DR. DONCASTER deals in a masterly way with a problem as difficult as it is fascinating, and his book is a fine illustration of scientific method. He states a theory and presents the evidence, and when the reader has just begun to enjoy a sense of satisfaction, more facts are brought forward which show that the theory breaks down, and that we have still much to learn regarding the determination of sex. It is a pleasure to follow a discussion which is so keenly critical and at the same time open-minded. Those who know Mr. Doncaster's book on heredity will expect lucidity in his treatment of a cognate subject, and they will not be disappointed. He goes deeply into things, but it is all clear, including the glossary. The illustrations are interesting and instructive. An indication of the scope of the book may be given in the chapter-headings: The problem; the nature and function of sex; the stage of development at which sex is determined; sex-limited inheritance; the material basis of sex-determination; the sex-ratio; secondary sexual characters; the hereditary transmission of secondary sexual characters; hermaphroditism and gynandromorphism; general conclusions on the causes which determine sex; the determination of sex in man. The author does not deal with the subject in its entirety, the case of plants, for instance, being deliberately left out, but selects for illustration and discussion the lines which seem to him most promising.

Dr. Doncaster's general position may be stated. In some cases sex appears to be determined already in the unfertilised ovum, for male-producing and female-producing ova are formed. In other cases sex seems to depend on the spermatozoon, and to be fixed at fertilisation; thus, to take a simple case, the unfertilised ova of the hive bee develop into males, and there are many instances now known of two kinds of spermatozoa differing in respect of their chromosomes. In a few cases there is evidence that sex may be modified during embryonic development or even later. Many facts point to the conclusion that a sex-determining factor sometimes resides in special sex chromosomes, and is inherited like a Mendelian character (as was first suggested by Bateson and by Castle). Individuals which receive it from both parents would be of one sex; those to which it is transmitted by one parent only would be of the other sex.

But the author goes on to point out that there are many facts which do not fit in with this theory. There is evidence that the ovum may influence the sex in cases in which observations on the chromosomes indicate that the sex should be determined by the spermatozoon; and there is evidence that the sex may in some cases be modified after fertilisation by influences acting on the embryo or some later stage. Therefore the author is inclined to give up the simple hypothesis of an unchangeable hereditary entity, the presence of which always causes one sex and its absence the other. He supposes that sex is dependent on a physiological condition of the organism, depending on the interaction of certain chromosomes with the protoplasm of the cells, and therefore determined, in the absence of other disturbing factors, by the presence or absence of these particular chromosomes. But where the determination expressed by the chromosome difference is not decisive, other conditions may have their influence. "Put in different words, every germ-cell would bear a sex-determining factor, but when this factor has relatively small intensity of action, its effect may be counterbalanced by other causes which alter the physiological relation on which sex-determination depends."

As to Man, the evidence from the study of chromosomes is at present unsatisfactory, but it is maintained by some that Man is one of those species in which the male has one chromosome less than the female; all the ova contain an X-chromosome (supposed to have a sex-determining function), while half of the spermatozoa have it and half have not. When two X-chromosomes are present in a fertilised ovum it develops into a female; when only one, into a male. But apart from the chromosomes, there are some other facts which point to the conclusion indicated. The most important of these is the sex-limited transmission by the male, as seen in the inheritance of colour-blindness, night-blindness, and hæmophilia. "If a man transmits certain characters always or nearly always to his daughters, the conclusion can hardly be avoided that he produces two kinds of germ-cells, female-producing which bear the factor for these characters, and male-producing which do not." If sex in man is determined solely by the spermatozoon, "there is no hope either of influencing or of predicting it in special cases." But if the ovum has some share in the effect, as some other facts suggest, if there are two kinds of ova, or if the physiological condition of the ova is alterable, the possibility of influencing the sex of the offspring through the mother is not excluded. The author regards "the control of sex in Man as an achievement not entirely impossible of realisation."

As regards the differences between the sexes, with which the author is not specially concerned in this volume, the view is entertained that "the physiology of the female is relatively anabolic, that of the male catabolic in character. That this should be so is perhaps a necessary consequence of the difference in function between the sexes. . . . It is interesting to speculate, however, whether the active, vigorous habits of the male and the restless movement of the spermatozoon on the one hand, and the quieter habit of the female and the passivity of the egg on the other, may not each be due to fundamental catabolic and anabolic tendencies, characteristic of maleness and femaleness, quite apart from the exigencies of reproduction."

This speculation is luminous and interesting, but we should have liked it better if reference had been made to the fact that it was advanced more than a quarter of a century ago by Prof. Patrick Geddes. It may be, however, that this is just another illustration of great minds thinking alike.

X-RAYS AND CRYSTALS.

X-Rays and Crystal Structure. By Prof. W. H. Bragg and W. L. Bragg. Pp. vii + 229. (London: G. Bell and Sons, Ltd., 1915.) Price 7*s.* 6*d.* net.

A BOOK in which are gathered together the results so far obtained in the new field of research concerning X-rays and crystals is particularly welcome at the present time, and especially from Prof. Bragg and his son. For not only have they carried the subject very much further than its initiators, Drs. Laue, Friedrich, and Knipping, but they have also given us an entirely new mode of experimenting. Indeed, in the hands of the English observers the investigation has already borne surprisingly important results, both as regards experimental confirmations of the views of crystallographers based on crystal measurement and as regards the nature of the X-rays themselves. The book will be gladly received by all who desire to explore the possibilities of the new method of attack, as it affords much-needed detailed descriptions of the apparatus employed, and instructions for its use.

The photographic diffraction method of Laue only receives a relatively small amount of attention, as the Bragg method, which involves the use of the X-ray spectrometer, is shown to be much more capable of affording indications of the internal structure of the crystal in the more complicated cases. It is clearly shown, however, that the two methods are mutually complementary, and lead to essentially the same result, with the advantage of detail on the side of the spectrometer, and permanence of record on the side of the photographic radiogram.

The whole subject is still so fresh that it might have been considered premature that a book should yet be written concerning it. But the results obtained already are so clear, and the stage reached may so truly be said to be one at which the initial difficulties have been overcome in the simpler cases tackled, that this book is in reality fully justified, and should prove of great use in attacking the immense difficulties which are presented by the more complicated crystalline chemical compounds. It may be that our first transports over the opening-up of so remarkable a new field of research may have to be modified, as it appears to be only capable of yielding unmistakably intelligible indications in the very simple cases, those of the chemical elements and their binary and ternary compounds, and not to be generally capable of indicating hemihedrism. For Friedel has shown that only eleven different types of radiogram are afforded by the thirty-two classes of crystals. It was hoped that it might throw a clear light on the much-discussed Pope-Barlow conception of valency, as dependent on the relative volumes of the spheres of influence of the various elementary atoms in a crystalline compound. But so far the indications are not favourable to that theory, and have led its propounders to doubt the value of the X-ray results. The chief substance studied which has afforded indications is the diamond, the analysis of which with the aid of the X-ray spectrometer is perhaps the most brilliant piece of work carried out by the Braggs. Whatever its indications may be as to the nature of the packing of the atoms and the sizes of their spheres of influence, there can be no doubt that the structure arrived at in the case of this, the most interesting, form of carbon is one which must commend itself both to the crystallographer and to the organic chemist as bearing the impress of truth.

The book will be found to afford much information concerning the properties of X-rays, as revealed by the Bragg spectrometer, and details of the investigations of all the simple crystalline substances which they have studied by its aid. The main work of the authors has been to show that the different orders (first, second, and third) of reflection, at the specific angles for maximum effect experimentally found for certain "monochromatic" X-radiations, correspond to reflections from different sets of planes among the whole parallel series of planes of atoms present in the part of the crystal penetrated by the rays, that is, to consecutive planes, alternate planes, and sets composed of every third plane; and from the intensity (if present) or absence of the different orders of reflection most important conclusions have been derived as to the constitution of these several planes of atoms, that is, as to the distribution in them of the atoms of the different chemical elements present in the crystallised substance. Moreover, the actual distances apart of the planes, and therefore of the contiguous atoms, have been calculated.

As regards the crystallographic bearing of the work described in this book, it may be unhesitatingly affirmed to afford ample confirmation of the structure of crystals which has been accepted during the last decade, as being indicated by the combined results of the work of experimental crystallographers and theoretical geometricians; this is certainly true so far as that structure has been authoritatively stated in such works as the latest edition of von Groth's "Physikalische Krystallographie," Miers' "Mineralogy," or the "Crystallography and Practical Crystal Measurement" of the writer of this review. It thus proves up to the hilt the solid ground-work on which the science of crystallography is now built, while throwing little light upon, and giving as yet no countenance to, the more speculative theories which are the matter of current discussion. It reveals crystallography more than ever as the handmaid of chemistry, and enhances a hundredfold the necessity for a much more universal study of crystals than has hitherto been recognised. Crystallographers are deeply grateful to Prof. and Mr. Bragg for their highly interesting and timely book.

A. E. H. Tutton.

SIR HIRAM MAXIM.

My Life. By Sir Hiram S. Maxim. Pp. ix + 322. (London: Methuen and Co., Ltd., 1915.) Price 16*s.* net.

To write in the first person singular is not according to the English temperament; even the best autobiographies annoy us, and the more we admire a man the sorrier do we feel when reading his life. Therefore it is thought to be better "form" to let a friend write one's life. But if we are to know Sir Hiram Maxim, we must listen to him telling his own story in his own way; we must not only bear with him when he shows pride in his performances, we must try to sympathise with him. He is a naturalised British subject; he was knighted; he is known in good society; he has received many orders and honours and hospitality from our own and foreign rulers. He is proud to be a British subject, and we are proud of the reasons he has given in this book for his change of citizenship, but in every line he shows that he is an American. He reveals himself as no Englishman dare do, but if the reader will only call to mind the fact that there are other formulæ of behaviour than his own, he will find the book well worth reading.

Sir Hiram Maxim was born in 1840 in the State of Maine; he had very little school education; he had a childhood and youth full of hard work. We know from many sources the conditions of young life sixty years ago in Maine and the New England States. In many ways it resembled the conditions in country places, not in England, but in Scotland and the North of Ireland, only that in Maine there were no rich people and there were few who were even moderately well to do. There was almost no money; wages were paid in kind, in orders upon shops for provisions. Everybody had a rather hard life full of manual labour, and therefore young Maxim did not in the least repine at his lot, which might seem to some of us a very hard lot. He is still proud of his muscular strength, which is greatly due to the work of his youth. He recounts with pride how, when quite young, in woodwork, lathe work, and work with various hand-tools to which he was sometimes unaccustomed he greatly outstripped other and much older workmen. Whatever chances of school there were he seized, in spite of long working hours. In Maine and Canada there was little skilled labour, so that the ingenious, energetic young man found that he could make a reputation quickly in any trade that he took up, and he succeeded in many trades, even in what may elastically be called landscape painting.

To such a boy everything gave occasion for thought and invention, and the inventions which he seems to be most proud of are those early inventions with which his name is not much connected now. Many of them have been greatly developed, but he reaps no share of the large fortunes that they have created. He had plenty of opportunity of studying human nature. He was evidently always abstemious himself, but he even had the experience of tending a drinking bar for a short time. He was peace-loving, but he was compelled on many occasions to show that he could fight, and he seems to have been a fine fighter. He gives few dates, and his age when any particular event happened can only be guessed at very roughly. This does not much matter, because at the age of twenty and at the age of forty he was the same independent, optimistic youth, eager for work and invention, gradually becoming skilled in the use of the best tools in doing fine metal work, able to turn his hand to glass-blowing and draughtsmanship and half-a-dozen other arts, with a good working knowledge of chemistry, electricity, and other parts of physics; he was always proud of his strength and health.

He made many inventions: mousetraps, gas machines, sprinklers to put out fires, a steam trap, locomotive head-lights, incandescent platinum and carbon electric lamps, the electric regulator for which he received the Légion d'Honneur; he demagnetised watches, and did many other interesting things. He relates many amusing anecdotes which illustrate the condition of things fifty years ago in Canada and the northern and also in the southern States.

He was probably thirty-eight when he discovered that heating carbon in a hydrocarbon atmosphere caused carbon to be deposited in a very hard form; we are not sure that he really claims the method of "flashing" a carbon filament by keeping it hot in a hydrocarbon atmosphere, but the suggestion of a claim is evident. About the age of forty he was greatly engaged in the manufacture and use of dynamo machines, and he exhibited excellent lamps at the Paris Exhibition of 1881. Soon after this, in London, he invented and exhibited his automatic gun; a single barrel which discharged more than six hundred ordinary rifle shots per minute, and for the next twenty years his time was mainly taken up in developing automatic guns of greater sizes. He records some of the praise which has been bestowed upon his gun; no praise can be too great for it. We remember a toast which was drunk enthusiastically in London when the news of a certain conquest had just been published "To the Conqueror of Matabeleland, Hiram Maxim."

He made discoveries about gunpowder and other explosives. He seems to be the first inventor of a smokeless powder. He describes all these things, but does not seem to think them of much more importance than his experiments on the roasting of coffee.

He seems to have been the first to see clearly how a flying machine might be made to work, and spent a very great deal of money in driving inclined planes horizontally through the air by means of an engine and air propellers, so that there should be sufficient vertical lifting force upon the planes. His machine did lift, and he seemed to be succeeding slowly, but his real difficulty was in the great weight of engine required. The invention of the petrol engine easily made the aeroplane a real flight machine. His fellow directors seem occasionally to have thought that there was a loss of dignity in his allowing advertisements to appear of such things as his inhaler for asthma, and scientific friends deplored his "prostituting his talents on quack nostrums." His own comment upon this is that from their point of view the invention of a killing machine was very creditable, but it was a disgrace to invent an apparatus to prevent human suffering. Just so, there are the two points of view. All through his life Sir Hiram was keen upon inventing anything that might be useful. He does not feel a loss of dignity in describing how he invented a simple, thoroughly good method of giving a proper surface to a black-board in a school, and he is no more ashamed of advertising his inhaler than of advertising his gun.

His experience of lawyers and business men in America seems to make him rather bitter towards Americans. It is gratifying to find him saying: "The reception that I received in England and the straightforward honesty of the gentlemen with whom I had to deal, gave me a very favourable opinion of the English character." J. P.

APPEARANCE AND REALITY.

(1) *William James and Henri Bergson: A Study in Contrasting Theories of Life.* By Dr. H. M. Kallen. Pp. xi + 248. (Chicago: University of Chicago Press; London: Cambridge University Press, 1914.) Price 6*s.* net.

(2) *The Mirror of Perception.* By L. Hall. Pp. 129. (London: Love and Malcomson, Ltd., 1914.) Price 2*s.* 6*d.*

(3) *What is Adaptation?* By Prof. R. E. Lloyd. Pp. vii + 110. (London: Longmans, Green and Co., 1914.) Price 2*s.* 6*d.* net.

(4) *The Story of Yone Noguchi: Told by Himself.* Pp. xi + 255. (London: Chatto and Windus, 1914.) Price 6*s.* net.

(1) NOT the least useful contribution to philosophy made by William James was a negative one, viz., the ignoring of the traditional antithesis between reality and appearance. This antithesis may safely be said to have been the original sin of metaphysics since meditation began, and James's philosophy may most fruitfully be studied from this starting-point. The older philosophers, logical and static, discriminated between appearance and reality "in one or all of the compensatory terms of God, freedom, immortality, and cosmic unity"; and later, "in response to the pressure of rapidly growing sciences, men faced fact, only to change it in such wise as thereby to satisfy the inner need for logical consistency." But James "insisted

that each event of experience must be acknowledged for what it appears to be, and heard for its own claims. To neither doubt nor belief, datum nor preference, term nor relation, value nor fact, did he concede superiority over the others. . . . Pure experience knows no favourites. He admits into reality . . . evil as well as good, discontinuities as well as continuities, unhuman as well as human, plurality as well as unity, chance and novelty as well as order and law."

Though between James and Bergson there is no little spiritual sympathy, a profound difference exists in the methodology of the *Weltanschauung* of each thinker. "Where," says Dr. Kallen, "Bergson beholds a universe, James sees a multiverse. . . . James is a democrat in metaphysics. Bergson, on the contrary, is a monarchist. For him the distinction between appearance and reality is aboriginal and final. For James it is secondary and functional." For James, "being is neutral," and he ignores, practically, the difference between "being" and "not being." Hegel laboriously proved them to be the same. James deals with reality just as it comes to cognition. Reality to him is "alogical," as Dr. Kallen puts it. Kant began the attack on logical metaphysics, inventing "epistemology" to assist him towards a *locus standi*. He, no less than any of the ancients, would have nothing to do with "common-sense reality." And no one expects any philosopher to consider it. But, to return to Bergson and his notion of philosophical reality, it is remarkable with what *élan* the French thinker embraces his self-found "truth." It is *durée réelle* (pure duration), a *poussée formidable* (a formidable thrust), the *élan vital* (the onrush of life); but its eternal enemy is matter and space, which distort it and by which it is distorted. Bergson's "flux" is a richer concept than that of Heraclitus, but it is of the same order. You would expect him to prefer instinct to intellect. But no one nowadays would place intellect, reason, first in the cosmic hierarchy. Both Bergson and James have contributed to this result. From the pragmatist point of view truth is "what we live by"; "common-sense, religion, art, and science are tools and modes of life, and therefore pragmatic." But, for Bergson, "truth is absolute," and his "truth" is vitalism writ large, after a course of Plotinus, Driesch (?), and Darwin.

(2) It is somewhat stimulating to find a disciple of Berkeley crying in the wilderness of to-day. Mr. Leonard Hall puts forward a "metaphysical theory" which is "a particular form of psychophysical parallelism, in which it is maintained that the physical world is the appearance, or image, of the psychical world, *in the distorting mirror of perception*" (my italics). It is a clever *tour de force*, though it is apparently quite serious. Granted the major premiss, everything comes out satisfactorily. Mr. Hall commences with the old antithesis of appearance and reality, and argues that "the initiating cause of all perceptions of the same material body is, not the body itself, but a reality of which the body is the image in the distorting mirror of perception." For Berkeley the initiating cause was God; for modern science "the initiating cause of all perceptions of the same body is the body itself," which, by the way, is not the case; science does not dogmatise here. Material bodies are "unreal . . . they are the transfigured appearances, or images, of underlying realities. Further, according to this theory, space is unreal, a material body, like the image of an object in a mirror, being in unreal space." Mr. Hall concludes that every organism, from the protozoa upwards, is a "mind"; that man is the super-conglomerate of "minds," and that this hypothesis of summated minds explains evolution and the organic world.

(3) Prof. Lloyd has written a suggestive little book on adaptation. The proposition of the selection theory that "competition causes evolution" was made in order to explain adaptation and life in general. It regards organisms as fitting into something, which is called their environment, . . . and that this correspondence was brought about by the elimination, from the one side, of all that would not fit." But adaptation, according to Prof. Lloyd, does not, any more than life, require explanation. It is the teleological bias of man, the machine-maker, that institutes the wonder which leads to design, purpose, and adaptation theories. But adaptation is "its own explanation, since an unadapted thing could not live."

(4) The *Weltanschauung* of many philosophers has been based on æsthetic axioms. And in his way the artist is a philosopher; "the marbles of Phidias and the philosophy of Plato . . . obey the same impulse and express the same will—an impulse to make over unsuitable realities into satisfactory ideas, a will to remodel discordant nature into happy civilisation." The reminiscences of the Japanese poet, Mr. Yone Noguchi, are a case of æsthetic pragmatism. "Do you know," he says, "I am a shy, without-knowledge-of-the-world poet"? All his experiences have been acquired from the point of view of beauty. His description of Chicago is a good example. "Smoke means Chicago as flower means Japan; money means Chicago as art means Japan."

A. E. Crawley.

OUR BOOKSHELF.

A Manual of Oils, Resins, and Paints, for Students and Practical Men. By Dr. H. Ingle. Vol. I., Analysis and Valuation, by the author and J. A. L. Sutcliffe. Pp. 129. (London: C. Griffin and Co., Ltd., 1915.) 3*s*. 6*d*. net.

This small volume is intended for students, analysts, and works chemists who are familiar with general chemistry but have had little or no practical experience in analysing oils, or preparations which contain oils. It includes much of what one would put in a good notebook intended for personal use in the laboratory. A short introduction serves to refresh the reader's memory upon points in organic chemistry specially relevant to oils and fats, after which the authors give short accounts of the most approved chemical and physical methods used in examining these bodies. Theoretical explanations are included as well as practical details. For example, the chemical reactions concerned in the absorption of iodine by oils are described more fully than usual—though it is true that we have to look in more than one place for them. A chapter on technological analysis deals not only with oils, fats, and waxes as such, but with articles such as paints, pigments, and varnishes which may contain oil as an ingredient, and with allied substances, such as turpentine and gum-resins.

The correct interpretation of the results obtained would often require much more knowledge than could be obtained from the descriptions given. Information as to the origin and methods of preparation of the various oils is not within the scope of the work. It is understood, however, that further volumes are to follow, dealing with these matters. The book is a useful introduction to laboratory work in the subject.

Potting, for Artists, Craftsmen, and Teachers. By G. J. Cox. Pp. ix+200. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s*. 6*d*. net.

The book will prove a distinct help to an artist craftsman who wishes to "do something" with clay. The author is right in saying: "Too much stress cannot be laid upon the importance of close study of the best work, both ancient and modern, for it is a truism that however handily a craftsman may work, his output will be worthless if he has not, with his increasing powers of technique, developed a sound judgment and refined taste." The description of the various simple processes of pottery work is very exact, and the illustrations are admirable.

The book, indeed, is a simple, though thorough and concise, first tutor to an artist craftsman, and should, to use the author's words, "set one or two sincere students to the making of some of the many beautiful objects of utility and art with which the craft abounds."

The list of pottery terms is useful, though there are a few which are not employed in this country in the sense given by the author, for example, *clammings* in England means the doors of the kiln, and not simply the sand or siftings applied to the cracks in them; *pug* in this country is used to mean the mechanical wedging of clay; *galena* is classed by the author as highly poisonous, and lead as poisonous, whereas galena is practically safe to use, but there may be considerable danger in using white lead carelessly.

Bernard Moore.

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 Principle of Similitude.

When Lord Rayleigh directs attention to the neglect among physicists of the principle of similitude (Nature, March 18), he has perhaps forgotten the excellent paragraph in which Tait deals with the question in his "Properties of Matter." Curiously enough, one of Lord Rayleigh's first illustrations is also Tait's, namely, the fact that the velocity of waves on deep water is as the square root of their lengths, to which Tait adds the corresponding fact that the velocity of ripples is inversely in the same proportion.

The principle is of great use in biology, as Herbert Spencer was the first to show. By its help we understand how there is a limit set to the possible growth in magnitude of terrestrial animals; how, on the other hand, the whale gains in activity and speed the bigger it grows; why the ostrich is unable to fly; why the bee's wing vibrates so much quicker than a bird's; and why the flea can jump well-nigh as high as a man. And not less does the principle deserve to be borne in mind when we consider what must be the conditions of life in the most minute organisms: especially if there be any so small as that Micrococcus of the rabbit, the diameter of which is given in the books as only 0·00015 mm., or not far from the limits of microscopic vision.

D'Arcy W. Thompson.

It is rather curious that Prof. D'Arcy Thompson should refer to Tait's "Properties of Matter," for I fancy I might claim some part of the credit for the paragraph in question. In a review of the first edition (Nature, vol. xxxii., p. 314, 1885) I wrote:—"There is one matter suitable to an elementary work which I should be glad to see included in a future edition, viz., the principle of dynamical similarity, or the influence of scale upon dynamical and physical phenomena. It often happens that simple reasoning founded upon this principle tells us nearly all that is to be learned from even a successful mathematical investigation, and in the numerous cases where such an investigation is beyond our powers, the principle gives us information of the utmost importance."

And, after an example or two: "I feel sure that in Prof. Tait's hands this very important and fundamental principle might be made intelligible to the great mass of physical students." Though I believe I was in correspondence with him at the time, I do not remember to have seen Tait's second (or later) edition, and I can only wonder that it has not had a more marked effect in popularising the general principle.

Prof. Thompson's illustrations from biology (attributed in part to Spencer) are, of course, of first-rate importance.

RAYLEIGH.

The Age of the Earth.

SOME fifty years ago Kelvin announced that the temperature of the earth could not have been anything like its present value for more than some 20–30 million years. This estimate was based upon three independent considerations, namely, the temperature gradient inside the earth's crust, the amount of tidal friction, and the total amount of energy radiated by the sun.

The first of these arguments has been invalidated completely by the discovery of the radio-active elements. The other two arguments are scarcely affected by this event.

The geologists always found some difficulty in compressing the history of the earth, more especially of the sedimentary strata, into the period allowed them by Kelvin. Prof. Harker's presidential address before the Yorkshire Geological Society, reprinted in your issue of March 25, seems to show that there is a general impression abroad that Kelvin's estimates have been superseded, and that the discoveries in radio-activity allow one to assume a period of the order of thousands of millions of years since the earth has reached a constant state as regards climate. I should like to be allowed to state as succinctly as possible what difficulties this view entails.

The mean temperature of the earth is about 280° absolute. It therefore radiates about $1{\cdot}7 \times 10^{24}$ ergs per second into space.

Assuming the latest value $1{\cdot}92 \frac{\text{cal}}{\text{cm.}^2\text{min.}}$ for the solar constant, the earth receives $1{\cdot}72 \times 10^{24}$ ergs per second from the sun. Therefore the radiation from the sun just compensates the amount lost by the earth; in other words, the temperature of the earth is determined by the temperature of the sun. The possibility that the earth's temperature might have been maintained by radio-active processes before the sun was incandescent, and that the radio-active substances have died off since then need scarcely be discussed seriously. For quite apart from the well-known sterilising effects of the rays, any radio-active substances with a sufficiently long life to keep up the temperature of the earth for any considerable length of time would not disappear quickly. Uranium, for instance, only diminishes at the rate of about 1·5 per cent. in 100 million years.

One may conclude, therefore, that the time during which the earth can have existed in its present state cannot be greater than the time since which the effective temperature of the sun has been about 6000°, its present value. This time cannot exceed about thirty million years. For the sun loses energy at the rate of about $3{\cdot}8 \times 10^{33} \frac{\text{ergs}}{\text{sec}}$, and the total energy to be gained by a mass of $1{\cdot}97 \times 10^{33}$ gm., contracting to a radius $6{\cdot}96 \times 10^{10}$ cm., is $2{\cdot}2 \times 10^{48}$ ergs, assuming approximate homogeneity. (Taking the increase in density towards the centre into account does not alter these figures much.) Now even if one assumes that the whole of this energy was radiated at a rate of about $3{\cdot}8 \times 10^{33} \frac{\text{erg}}{\text{sec.}}$, *i.e.*, at the present rate, it will only last 18·3 million years. But any other supposition, namely, that the sun at one time emitted more or less energy per second, leads to a shorter period for the earth in its present state.

To explain a greater age it was necessary to find other sources of energy, and since neither the heat of chemical combination nor any possible increase in the specific heat was anything like large enough, the heat of radio-active transformations was invoked. This was perhaps excusable in the early days before very much was known about the laws governing these processes, but it seems quite inadmissible to-day.

It has been suggested that at the enormous pressure and temperature inside the sun radio-active processes might be modified, and even that ordinary elements might break up. A consideration of the quantitative relations involved shows that this is most unlikely. Though one can scarcely apply ordinary thermodynamics to radio-active processes one can certainly apply the general rule, which may also be developed from the quantum theory if desired, namely, that a reaction the energy of which is A ergs per molecule is affected chiefly by the collisions of atoms of energy of the order A. Now A is of the order 10^{-5} ergs in radio-active processes, and one can therefore only expect the temperature to affect those if an appreciable number of atoms have an amount of energy of this order. The average energy of an atom would be 10^{-5} ergs at about $5{\cdot}10^{10}$ degrees. Therefore even at 500 million degrees only one atom amongst 10^{40} would be moving fast enough to influence a reaction which liberates 10^{-5} ergs. Obviously 500 million degrees is quite beyond the bounds of possibility in any part of the sun. One must conclude, therefore, that any process which liberates anything like the requisite energy is unaffected by solar conditions, and takes place at the same rate on the sun as on the earth. Thus one must fall back upon the ordinary radio-active materials, and as Sir Ernest Rutherford has pointed out, one would only gain a paltry five million years even if the whole sun were composed of uranium. The only way out would seem to be to suppose that the sun was created some 10^9 or 10^{10} years ago out of special radio-active material which produces an enormous amount of energy, and that it has been breaking up ever since. This material does not exist on the earth though, so the earth would have to be the object of a special creation. Such an assumption, of course, can neither be controverted nor even discussed. But unless some such hypothesis is introduced, *i.e.*, unless the presumably radio-active solar material which liberates a quantity of energy sufficient to keep up the sun's heat for the desired 10^9 or 10^{10} years, is supposed to have been created by some inconceivable force at the epoch at which the sun is supposed to have begun to radiate, this material would have disintegrated long ago. It might be objected that the same holds good of uranium, that the fact that uranium exists in measurable quantities proves that it has not existed for a time great in comparison to $5{\cdot}10^9$ years.

This is doubtless true, but there is no real difficulty about assuming uranium or other radio-active substances to have been produced if one supposes the solar system to have been formed by the collision of two stars.

At the moment of collision the velocity of two stars half the mass of the sun would be $\frac{1{\cdot}15 \times 10^{13}}{\sqrt{r}} \frac{\text{cm}}{\text{sec.}}$, r being the distance between the centres of gravity. Suppose they both contained some lead, this would reach a temperature of the order $\frac{1{\cdot}1 \times 10^{20}}{r}$, *i.e.*, of the order $2{\cdot}10^9$ degrees at the moment of collision. As has been shown above, an appreciable quantity of radio-active material might be formed at such a temperature if some helium were present.

But of course the heat used up in forming these substances would cool the rest of the mass: any energy gained in radio-active form would be lost in the form of heat. It could never avail to explain a solar constant such as has been measured for longer than Kelvin's 20 million years. In other words, radio-active substances produced would act only as accumulators of energy, not as primary batteries.

To recapitulate: As Kelvin showed, gravitational energy can only account for 18·3 million years of sunshine at the present rate. Invoking radio-activity as a source of energy implies the assumption that unknown radio-active materials liberating considerably more energy than uranium were created by some unknown agency within a measurable period of time, and that these are now breaking up. This assumption is not necessary to account for the existence of uranium, as it is quite conceivable that a certain amount of radio-active matter might be produced afresh during every stellar collision. The energy of substances formed in this way would not be available to explain a greater amount of energy on the sun as their energy is abstracted from the gravitational energy, and has already been taken into account.

F. A. LINDEMANN.

Sidholme, Sidmouth, April 5.

Harmonic Analysis.

IN a paper which I read to the Physical Society last January (see NATURE, February 11, p. 662) I suggested that the best way of analysing a wave, the graph of which was given, was to apply the rules for the mechanical quadrature of integrals which are given in treatises in the calculus of finite differences. I am convinced that these methods when applied intelligently are much simpler and ever so much more accurate than most, if not all, of the methods in everyday use.

In the paper referred to above I applied a well-known method of mechanical quadrature (Weddle's rule) to the case of a semicircular alternating wave, the equation to the positive half of which is $y=\sqrt{x-x^2}$. I chose this wave because I found that the evaluation of the Fourier integrals for it by analysis was laborious. Prof. A. E. Kennelly, of Harvard University, has kindly written to me to point out that the equation to the curve can be readily put in the form—

$$y=J_1(\pi/2)\sin\pi x-(1/3)J_1(3\pi/2)\sin 3\pi x+(1/5)J_1(5\pi/2)\sin 5\pi x- \ . \ . \ .$$

where $J_1(x)$ is the Bessel's function of the first order. Hence from tables of these functions we get:—

$$y=0{\cdot}567\sin\pi x+0{\cdot}0939\sin 3\pi x.$$
$$+0{\cdot}0422\sin 5\pi x+0{\cdot}0252\sin 7\pi x.$$
$$+0{\cdot}0171\sin 9\pi x+ \ . \ . \ .$$

Very close approximations to these numbers can be obtained very simply by Weddle's rule. For example, if b_1 denote the amplitude of the first harmonic, we have:

$$10b_1=5y_{1/6}+\sqrt{3}y_{1/3}+6y_{1/2},$$

where $y_n=\sqrt{n-n^2}$, and hence $b_1=0{\cdot}568$.

To get an accuracy of the same order for the third, fifth, seventh, and ninth harmonics we must calculate or measure the lengths of 8, 13, 18, and 23 ordinates respectively. Doing this, we find that $b_3=0{\cdot}0942$, $b_5=0{\cdot}0423$, and that b_7 and b_9 are given correctly. It will be seen that from the practical point of view the simplicity and accuracy of the method in this case leave little to be desired. It has the great advantage that the amplitude of each harmonic can be computed independently of the others.

When the wave passes smoothly through the extremities of the ordinates we measure, we can apply the rule with confidence. Jagged or very distorted waves must be treated more carefully. For example, if we apply the rule to a rectangular alternating wave of height unity we find from the formula given above that $10b_1=11+\sqrt{3}$, and so $b_1=1{\cdot}27321$ approx. The true value is $4/\pi$, *i.e.*, 1·27324 . . ., and hence the error is less than 1 in 40,000. For a triangular alternating wave of height unity, however, if we apply the rule intelligently we get $b_1=0{\cdot}88$ . . . instead of 0·81057 . . . The error in this case arises from applying Weddle's rule through a point of discontinuity. If we apply it over one-quarter of the wave, it being necessary to measure six ordinates instead of three, we find that $b_1=0{\cdot}81056$ . . .

ALEXANDER RUSSELL.

Faraday House, Southampton Row, W.C., April 12.

A Mistaken Butterfly.

REFERRING to Prof. Barnard's letter so titled in NATURE of April 15, which describes the apparent mistake of a butterfly in visiting a peacock's feather as if expecting to "extract food," I think it probable that there are no animals that do not make mistakes at times. I observed an analogous mistake made by a species of Pieridæ—*Appias nero*—in Sumatra, as I have recorded in "A Naturalist's Wanderings," p. 130:—"In the open paths I netted scarlet Pieridæ . . . often flying in flocks of over a score, exactly matching in colour the fallen [withered] leaves, which it was amusing to observe how often they mistook for one of their own fellows at rest, and to watch the futile attentions of an amorous male towards such a leaf moving in the wind."

HENRY O. FORBES.

Redcliffe, Beaconsfield, Bucks, April 17.

The "Green Ray" at Sunset.

PROF. A. W. PORTER, in NATURE of February 18 (vol. xciv., p. 672), seems to think that the "green ray" is more of a subjective phenomenon than anything else, or at least often is so; but the fact that it is seen at sunrise also shows that in this case at least it is not a result of complementary colours. Besides, if it were a subjective phenomenon, one would expect to see it on every occasion when the sun set behind a clear horizon, whereas the sight is somewhat rarer. I once saw a lovely blue flash, and I read a description recently of a sunset in Palestine where the writer speaks of the sun vanishing like a blue spark. If you hold a lens almost edgeways on between your eye and a light and move it until it is quite edgeways on a few discs of light will be seen, and at last these vanish in a green or blue flash, the effect of dispersion.

35 Roeland Street, Cape Town, March 17.

HEALTHY ATMOSPHERES.

PHYSIOLOGICAL research has proved that the cause of discomfort felt in close, ill-ventilated rooms is due to the physical, and not to the chemical, properties of the atmosphere. We exclude gross contamination by products of imperfectly combusted coal gas, *e.g.* from defective gas fires imperfectly flued. These chemical products irritate the nose and throat, and one of them—carbon monoxide—is a poison. We exclude too, those mines and factories wherein certain poisonous products of industry may pollute the atmosphere. We are writing of rooms crowded with human beings, of over-heated, windless rooms. The percentage of oxygen in such crowded rooms is never reduced by more than 1·0 per cent., and at any of the mountain health resorts the concentration of oxygen is reduced considerably more owing to the attenuity of the air. Similarly the percentage of carbonic acid is never raised in crowded rooms to such a level that it has the least toxic effect. Within the lungs a constant concentration of carbonic acid of about 5 per cent. of an atmosphere is maintained. The acidity of the blood regulates the action of the breathing mechanism, so that both it and the concentration of carbonic acid in the lung are kept constant. The only result of breathing an atmosphere containing 0·5–1·0 per cent. of carbonic acid—the most crowded room does not contain more—is a slight deepening of the respiration by which the concentration in the lung is kept at the normal figure. It becomes difficult to maintain the normal concentration in the lung when the concentration in the atmosphere rises above 3·0 per cent.; the breathing of even a resting man then becomes over-laboured. The crew of a submerged submarine feels the need for fresh air when the CO_2 concentration rises above this level.

Exact experiment, made by many competent researchers, wholly fails to confirm the assertion, so confidently made in all popular books of hygiene, that the expired air contains a subtle organic poison. The air of a crowded room smells offensive to one coming in from the fresh ar. and it may, and often does, infect us with the living germs of disease, sprayed out from the mouth, or nose, of those who cough, sneeze, or speak, but it contains no organic chemical poison, and the fatigue and headache felt by the more sensitive occupants is certainly not due to such. These effects are produced by the physical properties of the atmosphere acting upon the nose and skin, on that enormous field of sensory nerves which supplies the surface of the body, contributes so greatly to our feelings of well-being, and regulates the metabolism of our bodies. The cutaneous and nasal sense-organs are influenced by the temperature, movement, and vapour pressure of the air, and the physical qualities of the atmosphere, which control the loss of body heat by convection or evaporation. Out of doors we are ceaselessly stimulated by the play of wind; cloud, and sunshine, cold and heat, wet and dry alternate; monotony, the curse of the nervous system, is repelled. Cool, moving air braces us up; we are made active, eat more, and breathe more to keep up our body furnace. The daily turnover of the body is thus enlarged, the appetite is stimulated, and the food eaten is completely utilised and does not become dross and waste, the generator of bacterial decomposition in the bowel. The blood is refined out of a larger choice of foodstuffs, and the organs receive from it an ampler supply of the more precious and rarer building stones; the muscular exercise which we are compelled to take to keep warm, occasions the blood to circulate in ampler and quicker streams, and deepens the breathing, thus ensuring the proper expansion of the lungs, and the natural massage of the organs of the belly.

We are built to be active, and keep ourselves warm by muscular action. By over-clothing our bodies and over-heating our rooms we weaken our vigour, expose ourselves to nutritive disorders, and debilitate the natural mechanism of defence against infective disease. Moreover, in these heated, stagnant atmospheres we expose ourselves to massive infection by those carriers of disease who have in their respiratory tract some strain of microbe exalted in virulence, and thus spread "colds" or influenza, pneumonia, or phthisis. Mere exposure to cold does not cause these ills. Arctic explorers and shipwrecked people who suffer the extremes of exposure do not suffer in consequence from such illness. Excessive cold may cause local death and gangrene, or kill by cooling the whole body below a viable temperature, but our power to withstand cold is enormous, innate, the result of a million years of an evolution spent in struggling against the forces of nature. The inclement and dark wintry weather impels people to shut up windows, crowd into close, over-heated rooms, and thus expose themselves to massive infection.

The sedentary worker in heated, windless atmospheres runs his metabolism at a low level, and if he over-indulges in the pleasures of the table, easily becomes the sufferer from digestive and metabolic ailments. It is not the bad weather that causes the ill-health prevalent in the winter, but the excessive precautions most of us take to avoid exposure to cold. Only the very old and feeble, in whom the lamp of life burns low, want such protection. The young and the able-bodied require the stimulus of exposure to the weather; the discomfort arising therefrom soon results in vigorous health, and ceases to be felt. The soldiers of our new armies taken from shop, desk, or factory, and exposed in trench or camp, have been singularly free from disease which is supposed to result from chill, in spite of the hardship of cold, wet, and mud. Adequately fed, clothed, and rested, the open-air life has made the clerk, shop, or clubman twice the men they were, given them a healthy hunger, steady nerves, a clear, ruddy complexion, and increased weight, and yet for days together their clothes may have been damp.

The fear of cold and damp instilled in the nursery often checks the physical development of the young, and leads to a lessening of national vigour and health. The open-air school works wonders on the badly nourished, defective children, and should become the school of every child in the community. The camps of to-day placed in the wind-swept open spaces of the land are founded on the emergency of war, but should become the week-end playgrounds of the nation in times of peace. Our cities have been built so as to satisfy regulations based on the chemical theories of ventilation and the nursery-bred fear of cold. They should be re-planned so as to allow the maximum of sunlight and wind, affording baths and exercise grounds for all. The conditions of life at present wage a deadly war against us. We listen for the whirr of the Zeppelins, and take little heed of the silent sowing of the germs of preventible disease.

FIG. 1.—The Wet and Dry Katathermometer. The Dry instrument is shown enclosed in a wire cage, which was used for taking observations in investigations on clothing.

To secure these healthier conditions we require instruments which will measure the physical conditions of the atmosphere and make manifest the differences between confined and open air. The thermometer registers the average temperature of the surroundings; it gives us no information as to the rate of heat loss from the surface of the human body. It is the rate of heat loss which matters to us. Out of doors, on ideal spring days, the ground is warm and the wind scarcely moves at foot-level, while our heads are blown upon by a variable cooling breeze; the sun warms one side of us while the other is cool. The clouds chasing each other across the blue sky give us shade alternating with sun. Our feet are kept warm, our heads cooled, and our cutaneous nerves are continually excited by the ever-varying rate of cooling. There is no monotony, but an agreeable energising of our nervous system. When the heating and ventilating engineer gives us a uniform summer temperature of 63° F. by means of steam coil (so called) radiators, he secures us a warm atmosphere above and a cold floor below, cold feet and warm heads, and a deadly monotony of conditions. The right system of heating and ventilation would give us a warm floor and a variable, gentle, cool breeze moving round our heads.

In the House of Commons the engineer forces air, heated to 63° F., through a perforated floor, and thus, cooling the Members' feet, gives them conditions which lead to congestion of the mucous membrane of the nose and its air-sinuses, resulting in obstruction of the nasal airway, feelings of stuffiness in the head, and increased liability to infection by the germs of "colds" and influenza. A system more contrary to the outdoor ideal conditions could not have been invented. To measure the physical conditions outdoors and indoors we require an instrument which will measure the rate of cooling by radiation, convection, and evaporation, and will tell us whether the atmosphere is monotonous or not. The present writer has introduced the katathermometer for making these measurements, and with Mr. O. W. Griffith has introduced an electrical instrument, the caleometer, for the purpose of recording not only rate of cooling, but indicating whether the atmosphere is monotonous or lively.

The katathermometer (Fig. 1) is a large-bulbed spirit thermometer, made (by Mr. J. Hicks, 8 Hatton Garden) as nearly as possible of a standard size. Each instrument is tested against a standard one, and a constant obtained by which the rate of heat loss can be deduced in calories per sq. cm. of surface. The katathermometer is heated in warm water until the spirit just rises into the top bulb, and the column is free from bubbles. The instrument is then wiped dry and suspended in the atmosphere, and the time observed taken by the meniscus in falling from 100° F. to 95° F. This gives the rate of heat loss by convection and radiation, the instrument being approximately at body temperature. A muslin finger-stall is then drawn over the bulb and the operation repeated after heating the instrument and jerking the excess of water off the muslin cover. The time taken in this case gives us the heat loss by radiation, convection, and evaporation. The difference between the dry and wet readings gives us the heat loss by evaporation only, and from this, when the readings are taken in still air, the vapour pressure can be determined.

The value of rate of heat-loss measurements are seen by the following examples:—(1) Inside a cottage room on the East Coast and outside on the cliff edge the summer temperature was the same, but outside the katathermometer cooled much faster. It registers just as the human body feels the bracing effect of the moving air. It acts as an anemometer, sensitive not only to currents in one direction, but to every eddy which the ordinary anemometer fails to register. The instrument shows the vast difference between the conditions of the indoor and outdoor worker. (2) In the debating chamber of the House of Commons the thermometer registers a temperature of 63° at foot and head level, but the katathermometer shows the rate of cooling is 50 to 100 per cent. greater at foot level than at head level. When the conditions were experimentally altered in one part of the House so that all floor inlets were closed, and the air introduced at the gallery level, the rate of cooling became slower at foot level than at head level. Then the congestion of the nose was relieved as the feet became warm and comfort was secured. (3) In a room heated by a gas (so-called) radiator with window open at top a few inches, and three doors, beneath

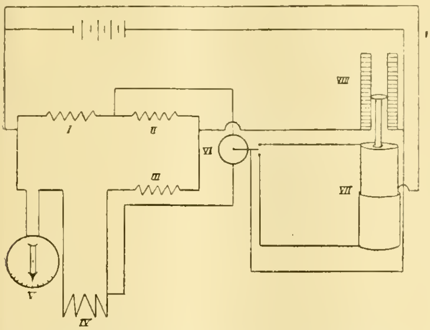

FIG. 2.—Diagram of the Caleometer. I., II., III. and IV. are the arms of a Wheatstone Bridge. When the caleometer coil IV. becomes warmer than 40° C. the index of the galvanometer VI. (used as a relay) goes upwards in the diagram and completes the circuit which includes the upper half of the electro-magnetic coil VII., the soft iron plunger moves then upwards and increases the resistance in VIII., less current then passes and the coil IV. cools. When the caleometer coil IV. cools below 40° C. the index of the relay VI. moves downwards and completes the circuit which includes the lower half of the coil VII. and this pulls down the slider and lessens the resistance in VIII. V indicates the watts or calories required to keep IV. at 40° C.

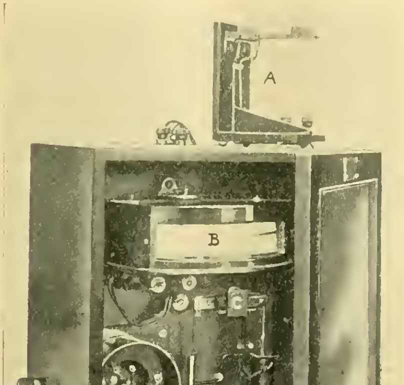

FIG. 3.—The Caleometer. A, caleometer coil. B, watt meter. C, travelling slider. D, magnetic coils surrounding soft iron plunger which moves in oil-bath. A string passes from the plunger over a pulley wheel on the slider to a counter-balancing weight and actuates the slider. E, the galvanometer acting as relay.

which the draught entered, the feet felt very cold and the head felt stuffy, the nose was congested, and the conditions for comfortable mental work at a desk were bad. The katathermometer showed that the rate of cooling at foot level was 40 per cent. greater than at head level. On heating the same room by a properly flued gas fire, and securing warm feet by exposing them to its radiant heat, comfort was at once secured. The katathermometer showed that the rate of cooling at the level where the feet were was 30 per cent. slower than at head level.[1]

The caleometer, by its automatic action, indicates the amount of heat energy required to keep a small coil of wire at body temperature. The oscillations of the indicator show the cooling effect of moving air and the variations of air currents. If the atmosphere is still and monotonous, the oscillations of the indicator will be small and few in number.

Records of any number (up to eight) of caleometer coils, placed in different parts of, say, a factory, can be taken by using a self-recording watt-meter.[2] The instrument is seen in Fig. 3.

LEONARD HILL.

AIDS TO NATURE-STUDY.[3]

(1) THE entomologist's walk in life is in many respects an enviable one, for it is his particular business to study creatures which often exhibit great beauty, amazing variety, and a strange subtlety of behaviour. The current of research as regards molluscs or mammals, let us say, has a strong, quiet flow, but that in entomology recalls a mountain stream with novelties and surprises at every turn. We feel this more than ever as we read Mr. Step's fascinating "Marvels of Insect Life." With the aid of beautiful photographs, many of them from his own camera, he gives us a lively sense of the wonderful intricacy of insect-behaviour, which often seems like a caricature of that of higher animals. But no one knows what its most accurate psychological interpretation may be.

The author writes with clearness and accuracy, and there is no fussiness in his enthusiasm. He is to be congratulated on having secured Mr. Theo. Carreras as a draughtsman, for the full-page plates are exceptionally clever, and most of those in colour are as successful as they are daring. In its whole get-up the book is certainly at high-water mark. Two minor features may be mentioned which show that there has been careful consideration of what an intelligent reader reasonably expects and rarely gets. One is that the technical names of the insects dealt with are

[1] Volunteers who will undertake daily readings with the katathermometer are asked to communicate with the writer (London Hospital Medical College, E.). He is seeking to secure during the next six months records of open-air conditions in representative parts of Britain, and of those conditions which obtain in houses, schools, and factories.

[2] The instrument is made by Mr. Robert W. Paul, Newton Avenue Works, New Southgate, London, N.

[3] (1) "Marvels of Insect Life. A Popular Account of Structure and Habit." Edited by E. Step. Pp. viii+486. (London: Hutchinson and Co., n.d.) Price 10s. 6d. net.

(2) "Nature Notes for Ocean Voyagers." By Capt. A. Carpenter and Capt. D. Wilson-Barker. Pp. xvi+181. (London: C. Griffin and Co., Ltd., 1915.) Price 5s. net.

(3) "The Drama of the Year." By Mary Ritchie. Pp. x+118. (London: T. C. and E. C. Jack, 1915.) Price 2s.

always given (at the foot of the page in this case); the other is that the illustrations are furnished with adequately detailed descriptions in small but clear type. We have but one fault to find, that we can discover no order in the marvels. They form a delightful volume, but not a unified book. Or are we overlooking some arrangement which is subtle as insect behaviour itself? Perhaps we are ultra-sensitive, but we like to be orderly, even in our pleasures. It is interesting to find that Mr. Step vouches for the mother-earwig's hen-like care of her offspring, as to the reality of which Mr. Brindley's careful observations recently raised some doubts. We may also note that the author's account of cuckoo-spit (Fig. 1) is not quite up-to-date.

Photo.] FIG. 1.—"Cuckoo-spit." From "Marvels of Insect Life." [*H. Bastin.*

These are small points, however, and what we particularly wish to say is that we can think of no introduction to entomology which surpasses the volume before us in its capacity of gripping the beginner and prompting observation. Would one know of the mouse-catching locust from the Congo, of the Kanchong Mantis which is so like a flower that butterflies visit it, of nightmare insects that look like jokes in morphogenesis, of the big blue wasps of Texas which are able to overcome the huge bird-spiders, of the growth of the caterpillar of the privet hawk-moth which increases its weight nearly ten thousand times in thirty-two days, of the long-necked ant-lion of the pyramids which has its prothorax pulled out into an instrument for reaching down into crevices, of the whimsical leaf-legged bug of South America (Fig. 2), of the maternal bug of the birch-tree which covers her offspring as a hen her chicks, of the peculiar aquatic larvæ of the fly whose bite is said to cause the strange skin disease called pellagra, of the stalk-eyed fly that has its eyes and minute antennæ borne on relatively long lateral extensions of the head, of the quaint way in which the larvæ of the pear-tree hover-fly deal with aphides, of the giant water-bug of Trinidad which sometimes kills frogs — of these and a hundred other marvels, is it not written in the captivating book of Mr. Step?

(2) Captains Carpenter and Wilson-Barker address themselves to the voyager who wishes to know something, but not too much, about what is to be seen from a ship's deck—the ocean itself and all that in it is. They deal in an interesting way, without going very deeply into things, with the physical features of the sea, with the whales

Photo.] [*H. Bastin.*

FIG. 2.—Leaf-legged insect from South America. The very long and slender hind-legs spread out at the top of the shank into prettily-coloured leaf-like growths which must tend to disguise the insect's true nature when seen upon foliage. From "Marvels of Insect Life."

and seals, the petrel and the albatross, the fishes and cephalopods, the Portuguese Man of War and the coral reef, with the seaweeds, the microscopic plankton, and the phenomena of phosphorescence, with the winds and the clouds, with the waves and their measurement. They have also something to say regarding old sea monsters and old sea customs and chanteys.

Captain Carpenter was a lieutenant on the *Challenger*, and has had other opportunities of deep-sea work; his collaborator, Captain Wilson-Barker, served afloat for twenty years, in part in connection with deep-sea telegraph cable work; so the joint authors have been for a long time in intimate association with the life about which they write. There is a pleasant directness in the book, and a not less pleasant smell of the sea. There are numerous excellent illustrations, many of them

FIG. 3.—Black-backed gull. From "Nature Notes for Ocean Voyagers."

old friends, others delightfully fresh (Fig. 3). We believe that many amateurs will enjoy this book very much and profit by it in proportion. It ought to be in all ship libraries.

We must note, however, that the authors would have been well advised if they had availed themselves of the services of some competent naturalist to remove numerous inaccuracies which are as flies in the ointment. Thus it is a blemish to speak of the parrot's beak of the sea-egg, of the air cells beneath the gannet's skin being the main factors in the bird's powerful flight, of the parrot-like beaks of the puffin, of the Ctenophora progressing by small hairs (cilia) which outline their bodies, or of Noctiluca as a small jelly. The figure of the octopus (on page 81) with irregularly branched arms requires some explanation.

(3) Miss Ritchie has written a delightful informal introduction to nature study in South Africa, which will take teachers and pupils in that interesting country further into the heart of things than a more informative primer is likely to do. While it is thoroughly objective, dealing mainly with the succession of flowers in a country with a fascinating flora, it touches things imaginatively as well as scientifically, and aims at the culture of appreciation and delight as much as at the diffusion of knowledge. There is a very interesting foreword by Prof. Patrick Geddes, and Mr. Allerston has supplied a fine set of illustrative photographs of characteristic South African plants. We wish the book good speed.

THREE NATURALIST-TRAVELLERS.[1]

THE chief feature common to these three books is that they deal with the researches of British naturalists in the belt of country which, from the Arctic Ocean to Equatorial Africa, lies along the boundary between Eurafrica and Asia.

(1) Mr. Bury's "Arabia Infelix" describes the eastern wall of the Great Rift Valley in south-western Arabia. The land lies low for about thirty miles from the Red Sea at Hodeida; it then rises by bold precipices to the height of from eight to ten thousand feet, whence the plateau sinks gradually eastward to the Great Red Desert of Arabia, at the level of from three to four thousand feet. The road inland to Sanaa begins its steep ascent through "The Gate of the Mountains," where a huge rock has fallen across the ravine and made a natural arch. By scaling cliffs of appalling steepness, up which the Turks have had the temerity to plan a railway, it rises to the height of 9000 ft. It passes through various zones of vegetation. The spurs and ravines are terraced for coffee or clad in thick jungle. The ravines are so steep and narrow "that one may almost touch the tree-tops which grow out of them, and so overgrown that only a green twilight penetrates to their recesses, where the lurid blooms of the snake-onion flame among the fern and the giant cobra drowses in the hush of noon." So steep are the precipices that "it gives one a crick in the neck to count the coffee-gardens up those outrageous steeps, while wondering if they are garnered with a derrick."

Mr. Bury writes with a unique knowledge of this part of Arabia, and his short book is packed with information. Unfortunately there are scarcely any references to the former literature,

1 (1) "Arabia Infelix; or, The Turks in Yamen." By G. W. Bury. Pp x+213. (London: Macmillan and Co., Ltd., 1915.) Price 7s. 6d. net.
(2) "Alone in the Sleeping-Sickness Country." By Dr. F. Oswald. Pp. xii+219. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1915.) Price 8s. 6d. net.
(3) "A Summer on the Yenesei (1914)." By M. D. Haviland. Pp. xii+328. (London: Edward Arnold, 1915.) Price 10s. 6d. net.

and no account of the structural geography, which is perhaps its most interesting feature. Mr. Bury is an ornithologist, and the natural history notes of most value are those dealing with the birds, the agriculture, and the climate. The book is enlivened with many flashes of humour, partly his own and partly quoted from the Arabs, such as the letters found on the bodies of those who fell in the war of 1871. "To my brother Gabriel. ——, son of ——, is coming to you; admit him to Heaven. (Signed) Mohamed Eyad, Emir of the Faithful."

Mr. Bury begins with a synopsis of the history of Yamen, and ends with a forecast of its political future. He hopes, in the interests of both Turks and Arabs, that the present war will lead to its independence, though he is obviously very doubtful whether the natives can manage the country by themselves. He appears to think that the best hope for Yamen is its annexation to the Aden Protectorate. He recognises the sterling merit of the individual Turk, and refers to Turkey's disastrous plunge into war with sympathetic commiseration; he attributes it largely to national anger at our retention of the two new battleships, for they had been built by public subscription, to which the Turks contributed their utmost as a religious duty. As he remarks, we should not like our subscriptions for a new cathedral to be arbitrarily diverted for the building of a mosque.

(2) Dr. Oswald, who is well known from his work on the geology of Armenia, visited the eastern shore of the Victoria Nyanza to search thoroughly some Miocene deposits which have yielded fragments of *Dinotherium hobleyi*, the most important palæontological discovery yet made in British East Africa. Dr. Oswald ransacked the beds, and traced them further inland, and obtained fragmentary remains of a fossil tortoise, an extinct elephant, the first baboons found fossil in equatorial Africa, and the first fossil Protopterus. He also found evidence of the once larger size of the Victoria Nyanza, as its beaches occur three hundred feet above the present lake level. He contributes a very interesting account of his experiences. He unintentionally interviewed a leopard, and was discovered by the ticks that carry relapsing fever, by tsetse fly, and other disease-spreading insects. He writes about the country with a naturalist's sympathy and insight. Even the white ants impressed him more as useful soil-makers than as destructive pests. He is too fond of animals to help the reduction of the diminishing herds of antelopes, and he strongly condemns the uselessness of killing the game to prevent the spread of sleeping sickness, since other animals and even insects can harbour the infection. The author has proved that the Miocene beds which he went to examine are disappointingly barren; but he has contributed a very useful addition to the geology of this part of British East Africa.

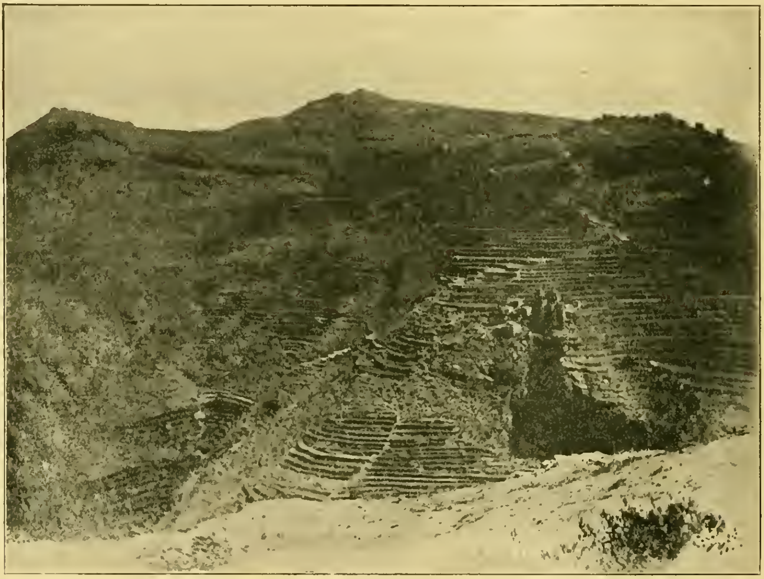

Fig. 1.—Field Terraces. From "Arabia Infelix; or, The Turks in Yamen."

(3) Miss Haviland is a well known ornitholo-

gist, who visited the northern Yenisei to continue the researches of Seebohm and Popham on the nesting habits of the birds which breed there. She tells the story of her expedition in a brightly-written volume, illustrated by excellent photographs, but lacking a map. The party consisted of four, of whom two, Miss Czaplicka and Mr. Hall, are wintering in the country of the Ostiaks, and may thus throw further light upon the affinities of these people. The declaration early in the book that "the journey across Asia by the Trans-Siberian Railway can never be anything but unspeakably tedious" is not an encouraging start; for though the author only saw the line in its most uniform section, the statement shakes faith in her geographical insight. But as soon as she reaches the Tundra she shows a truer appreciation of the country, and in many a graphic sentence expresses the charm of the northern nights, "when darkness was never deeper than a soft twilight glow, and the mysterious shining spears of the Aurora Borealis mingled with the glamour of a night-long dawn." She is very sympathetic to the people, though she gives a lurid picture of the prevalent drunkenness, for her visit was before the famous Ukaz of the Tsar which stopped the sale of spirits. She aptly summarises some of the most striking features in Russian conditions and culture. Russia she describes as "a country of enormous possibilities, of the crudest paradoxes. With the most autocratic government, hers is the most democratic society in the world; with a Church whose function has dwindled into the effete repetition of ritual, religion is the very fibre of her people."

In illustration of the severity of the climate Miss Haviland repeats the widespread saying that the population would die out at the third generation if not renewed by immigration; the statement is probably as trustworthy for Siberia as it is when asserted to prove the unhealthiness of city life and the impossibility of European settlement in the Tropics.

Miss Haviland spent most of her time photographing the nesting birds around Golchika on the estuary of the Yenisei; her chief prize was a curlew-sand-piper's nest, which was first taken by Popham in 1897. From that district she returned on the timber ships by which Mr. Jonas Lied is endeavouring to maintain annual communication between the Yenisei and western Europe, an enterprise on which depends the future of several Siberian industries. Her account of the Kara Sea in September will be a useful supplement to Nansen's account of his outward voyage with Mr. Lied at the beginning of the season.

J. W. G.

Fig. 2.—Manga escarpment, seen from the south-west. Note the numerous huts of the fertile district of Kitutu at the foot of the cliffs. From "Alone in the Sleeping-sickness Country."

PROF. W. GRYLLS ADAMS, F.R.S.

Born at Laneast, Cornwall, on February 16, 1836, William Grylls Adams, Emeritus Professor of Natural Philosophy in King's College, London, died at Broadstone, Dorset, on April 10, 1915, aged seventy-nine years. He was educated in a private school in Birkenhead, and entered St. John's College, Cambridge, of which afterwards he became a fellow. In 1865 he was elected professor of natural philosophy and astronomy at King's College, London, in succession to Clerk Maxwell, who had been appointed to the Cavendish professorship at Cambridge. In the same year he contributed to the *Philosophical Magazine* an article on the application of the principle of the screw to the floats of paddle-wheels, his sole contribution to applied mechanics. He took part in the eclipse expedition of 1871 to Sicily. In that year he investigated the action of a bundle of parallel glass plates on the polarisation of light, the results being published in vol. xli. of the *Philosophical Magazine*.

The next few years of Adams's life were very active. In 1872 his scientific merits were recognised by his election to the fellowship of the Royal Society. In 1875 he delivered the Bakerian lecture, on the forms of equipotential curves and surfaces, and lines of flow. The lecture was an exposition of an almost entirely experimental investigation of the curves which result when electric currents are passed through sheets of tinfoil between electrodes placed at different points; but some attempt was made to realise also some cases of three-dimensional flow. This paper has proved to be one of classical interest. In the same year he communicated to the Proceedings of the Royal Society a paper on the change of resistance produced by magnetisation in iron and steel. He observed a difference between the effects of longitudinal and transverse magnetisation. When the magnetisation was longitudinal, the electric resistance of hard steel was diminished, while that of soft steel or soft iron was increased; and in both cases the effect was approximately proportional to the square of the magnetising force. When the magnetisation was transverse a similar effect was observed.

The next subject investigated by Adams was the phenomenon of the effect of light in reducing the resistance of selenium, which had recently been discovered by Mayhew. With great patience and experimental skill he showed that the effect was not due, as had been supposed, to any heating of the selenium, but was a genuine result of illumination; and he proved that the change of resistance was greater for yellow-green rays than for any other part of the spectrum.

Adams was one of the founders of the Physical Society, in 1875; and to its first volume of Proceedings he contributed a description of a new form of polariscope for determining the angle between the optic axes of biaxial crystals. The crystal slice to be examined was placed between two pieces of glass, one being a hemisphere and the other a shallower section than a hemisphere, the convex surfaces having a common centre in the crystal slice. The combination was placed in oil between the usual crossed Nicol prisms, and could be tilted through any desired angles so as to bring first one and then the other of the optical axes of the crystal into alignment with the axis of the instrument, thus enabling the angle between the axes to be accurately measured without corrections for the refractive index.

In 1880 Adams was chosen president of section A of the British Association, and delivered an address dealing generally with recent progress in physics. He also presented a report of a comparison between the magnetograph curves from the magnetic observatories of Kew, Stonyhurst, Lisbon, Coimbra, Vienna, and Petrograd. In the following year he continued his magnetic investigations with a paper on the connection between magnetic disturbances and earth-currents. He wrote also on the development of lighthouse illumination, and with Dr. Hopkinson examined the performance of the De Meritens dynamos at the North Foreland lighthouse. As president, in 1884, of the Institution of Electrical Engineers, he took for the subject of his inaugural address the topics of the growth of electrical science and the testing of dynamo machines and incandescent lamps. He wrote a series of articles on electric light and atmospheric absorption, and another on lighthouse illuminants and apparatus, for publication in the *Electrician* in the years 1885 and 1886. After some years he returned to the subject of magnetic disturbances as recorded simultaneously on the magnetographs at several observatories, in a paper which was published in the Philosophical Transactions (vol. cviii.) in 1893. To the British Association report of 1898 he contributed an account of the determination of the Gaussian magnetic constants made many years previously by his elder brother, the astronomer, John Couch Adams.

Grylls Adams served on the council of the Royal Society from 1882 to 1884, and again from 1896 to 1898. He was president of the Physical Society in 1879. In 1883 he delivered a series of Cantor lectures on the subject of electric lighting. He retired from the professorship at King's College in 1906. He has left a widow, three sons, and one daughter.

NOTES.

WE record with much regret the death on April 16, at sixty-five years of age, of Mr. Richard Lydekker, F.R.S., distinguished by his original work and numerous writings on all aspects of natural science, and a constant contributor to NATURE for many years to within a few days of his death.

THE Paris Geographical Society has just made a special award of a gold medal to Dr. J. Scott Keltie, for his long and distinguished services to geographical science.

COLONEL G. W. GOETHALS, engineer of the Panama Canal, and Sir Thomas Shaughnessy, president of the Canadian Pacific Railway Company, have been elected honorary members of the Institution of Civil Engineers.

THE *British Medical Journal* announces that the Louis Livingston Seaman medal for progress and achievement in the promotion of hygiene and the mitigation of occupational diseases has been awarded to Major-General W C. Gorgas.

THE Warren prize of the Massachusetts General Hospital, of the value of 100*l*., and awarded triennially, is offered for the year 1916 for the best essay on some special subject in physiology, surgery, or pathology. Further particulars are obtainable from Dr. F. A. Washburn, at the hospital named.

WE learn from the *Lancet* that the Hutchinson Museum has been acquired by the Medical School of Johns Hopkins University. The collection comprises original coloured drawings; coloured plates taken from atlases, books, and memoirs; engravings, woodcuts, photographs, and pencil sketches, in some cases with the letterpress or manuscript notes attached. The collection illustrates the whole range of medicine and surgery, but particularly syphilis and skin diseases.

SIR THOMAS CLOUSTON, a leading authority upon the subject of mental diseases, died in Edinburgh on April 19, at nearly seventy-five years of age. He was lecturer on mental diseases at Edinburgh University, and was the author of a number of important works on disorders of the mind. He was president of the Royal College of Physicians, Edinburgh, in 1902–3, and was for some time editor of the *Journal of Mental Science*.

THE death is announced of Mr. J. B. A. Légé, who made the first tide-predicting machine for the late Lord Kelvin. He was the constructor of signalling lamps and other apparatus invented by Admiral Sir Percy Scott and used in the Navy. Among Mr. Légé's inventions may be mentioned horological mechanisms, torpedoes, and direct-acting petrol engines.

An International Engineering Congress will be held during the week September 20–25 next, at San Francisco, under the presidency of Colonel G. W. Goethals, chairman and chief engineer of the Isthmian Canal Commission, and under the auspices of the leading American technical and scientific societies. Applications for further information should be addressed to Mr. W. A. Cattell, secretary-treasurer, Foxcroft Building, San Francisco, U.S.A., from whom circulars and reply forms may be obtained.

The Christiania correspondent of the *Morning Post* announces the death of Prof. G. Gustafson, professor of Norwegian archæology in the University of Christiania. Prof. Gustafson was born at Gotland, Sweden, in 1853, and went to Norway in 1889 as keeper of the antiquarian section of the Museum at Bergen. He was appointed in 1900 professor of archæology at the University of Christiania, where he reorganised the archæological and prehistoric museum and conducted numerous excavations.

At a special meeting of the Conchological Society held at the University of Manchester in lieu of the ordinary February meeting, an illuminated address was presented to Mr. J. W. Taylor on attaining his seventieth birthday. The address directs attention to the fact that it is forty-one years ago since Mr. Taylor undertook the publication of the *Quarterly Journal of Conchology*, which later led to the inauguration of the Conchological Society. Mr. Taylor's great work has been the "Monograph of the Land and Freshwater Mollusca of the British Isles," of which three volumes are now completed.

We learn from the *British Medical Journal* that Dr. S. von Prowazek, director of the department of protozoology in the Institute of Marine and Tropical Diseases at Hamburg, has died at Lima of typhus fever contracted in the course of a research on the pathology of that disease. He was thirty-nine years of age, a native of Austria, and studied under Ehrlich, Hertwig, and Schaudinn. We notice also the announcement of the death of another worker in the field of tropical diseases, namely, Lieut.-Col. W. S. Harrison, formerly assistant-professor of pathology at the Royal Army Medical College. Lieut.-Col. Harrison was only forty-three years of age; and he appears to have contracted the disease from which he died on April 12 during research work in connection with tropical diseases in India and Jamaica.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on May 13 and 14. The Bessemer gold medal for 1915, which has been awarded to Mr. Pierre Martin, formerly of Sireuil, near Paris, will be received on his behalf by M. Paul Cambon, the French Ambassador, during the first meeting, and in the afternoon of the same day Prof. Hubert, of Liège University, will lecture on large gas engines. During the morning of the second day the Andrew Carnegie gold medal for 1914 will be presented to Mr. E. Nusbaumer, of Paris, and the award of research scholarships for the current year will be announced. Papers will be read and discussed on both days. The council of the institute has decided on account of the war that it will be inadvisable to hold the annual dinner this year. It has been decided provisionally that the autumn meeting of the institute shall be held in London during the week ending September 25.

It is proposed to place a bust of Sir Archibald Geikie in the Museum of Practical Geology, Jermyn Street, where there are already busts of all previous occupants of the post of Director-General of the Geological Survey and of the museum, as well as of several other distinguished geologists. Sir Archibald Geikie was connected with the Geological Survey for nearly forty-six years, during nineteen of which he was Director-General. A committee representative of the universities and the principal scientific institutions and societies of the United Kingdom has been formed to carry out the proposal. It is estimated that the cost of a bust and of a replica to be presented to Sir Archibald Geikie will be between 400*l.* and 500*l.*; and the committee invites subscriptions towards this sum. There should be no difficulty in securing the amount required for this modest form of memorial of a geologist of world-wide distinction, who was connected for so many years with the institution in which the bust is to be placed. Contributions for the fund should be made to the honorary treasurer, Mr. J. A. Howe, curator of the Museum of Practical Geology, Jermyn Street, S.W.

The South African Institute for Medical Research has issued a valuable monograph, "Anthropological Notes on Bantu Natives from Portuguese East Africa," prepared by Mr. C. D. Maynard, statistician and clinician to the institute, and Dr. G. A. Turner, medical officer to the Witwatersrand Native Labour Association, who have had excellent opportunities for studying these people. The paper supplies an elaborate series of measurements of this very mixed race—stature, brain weight, skull thickness, cephalic and cranial indices, spleen, liver, and kidney weights. The correlation of stature and brain weight is found to be only partially established, and the Bantu cerebrum appears to be rather lighter in relation to stature than that of the European. The current impression that the native's skull is thicker than that of the European is found to be incorrect. The article is provided with a useful bibliography of the subject.

The Smithsonian Institution has just issued an account, by Dr. J. W. Fewkes, of a collection of beautiful pottery from the Mimbres Valley of New Mexico, dating back to prehistoric times. This is the first collection received by the museum from this valley, and this type of pottery is unrepresented in other collections. Its importance lies in the fact that a comparatively large number of specimens have human or other figures painted upon them, and that they resemble those from Casas Grandes in Mexico. An interesting and significant custom of these people is that they buried their dead in urns, under the floors of their houses in a sitting posture, with a bowl inverted over the head like a cap, or, when the body is extended, over the face. Such bowls have always a small round hole in the bottom, which has been interpreted as due to the belief that pottery possesses spirits which can escape only when the vessels have been "killed"; possibly it is a mode of releasing the ghost of the dead man.

Dr. V. Ivanof has ascertained by microscopic observation the existence of leaves in saxaul (*Haloxylon ammodendron*). Other botanists have described the shrub as completely leafless or provided only with small, scaly growths. The leaves grow closely into the stem, and the apical parts and stalks form a continuous whole (Proceedings of the Society of Naturalists at the University of Kazan, 1912–13).

In the Journal of the Philadelphia Academy of Sciences for January, Mr. Matsumoto gives a preliminary account of a new classification of the feather-stars, or Ophiuroidea, the full details of which are to be published in Japan. The author, who has received valuable advice and assistance from Prof. H. Clark, finds that ophiuroids must be divided into two main groups, the first of which (Œgophiuroida) is mainly Palæozoic, and lacks most of the structural features by which Ophiuroidea are distinguished from Asteroidea.

According to an article by Prof. T. D. A. Cockerell in the issue of the Proceedings of the Philadelphia Academy for December, 1914, the well-known Miocene insectivorous beds of Florissant, Colorado, continue to yield a number of new forms, so that the time is still distant when it will be possible to publish a complete list of the fauna. Compared with the rich insect-bearing beds of Œningen, Baden, and of the neighbouring village of Wangen, on the Rhine, the Florissant fauna is markedly the richer, so far as definitely named species are concerned. The Œningen fauna, for example, comprises 250 beetles, 80 Hemiptera, 60 Hymenoptera, and 30 flies, but the members of these groups already named from Florissant number, respectively, about 494, 230, 220, and 100.

The Termites (so-called "white ants") afford unfailing interest to the entomologist. A valuable account of the bionomics of the species of these insects found in the eastern United States has been lately issued by T. E. Snyder (U.S. Dept. Agric. Entom. Bulletin, No. 94). Two species of the Leucotermes (*L. flavipes* and *L. virginicus*) form the subject of most of the observations recorded. The forms of these termites and the general course of their development have been fairly well known for many years past. Mr. Snyder has directed especial attention to the fate of the winged, sexual individuals that "swarm" from the nests at certain seasons. The survivors — often comparatively few — of these "swarms" usually cast their wings before courtship begins, and do not actually pair until they have established themselves in a new "royal chamber," which, in the case of Leucotermes, is a cavity in wood. It is not necessary for these "royal pairs" to be established by foraging workers and soldiers; they are apparently, as a rule, independent of help in the foundation of a new community. The provision of "neoteinic" royal individuals is associated with the foundation of fresh communities from old overcrowded societies.

In *Meddelelser fra Kommissionen for Havundersøgelser*, Serie Fiskeri, Bd. iv., No. 7, Dr. Johs. Schmidt discusses the classification of fresh-water eels (Anguilla). A considerable number of specimens from various localities have been investigated as regards the amount of variation occurring in different characters, the characters being additional to those which were discussed in a previous paper. It has proved possible to distinguish between three species, *A. vulgaris*, *A. rostrata*, and *A. japonica*. All European fresh-water eels belong to one and the same species, within which no constant local races can be shown to exist.

An attractive article in the April issue of *Wild Life* is one by Miss F. Pitt, illustrated by four reproductions of photographs, of the marten, in which particulars are given with regard of the past and present distribution of that species in Great Britain. Many readers of the same number will doubtless also be interested in a well-illustrated article by Mr. F. J. Stubbs on the plague-flea, and how it is carried about by rats, as well as the way in which it becomes infected with the plague-bacillus. It might have been added that the ultimate source of plague appears to be the indescribably evil-smelling burrows of the bobac marmot of the steppes of eastern Europe and western Asia.

In the January issue of the Journal of the Philadelphia Academy of Sciences Miss A. M. Fielde gives further particulars with regard to her investigations of the functions of the antennæ of ants. It has already been shown by the author that the function of these appendages is olfactory, and it is now demonstrated that their constituent segments take up particular kinds of odours. The distal segment, for example, warns an ant from approaching any colony other than its own. Again, the penultimate joint deals with the odour which renders one ant-colony inimical to others of the same species. Another segment serves to guide an ant on the homeward track by enabling it to pick up the scent left on the ground during its outward journey, while the function of yet another is to recognise the whereabouts of the queen and her undeveloped progeny on the part of a worker, and so on with other items in the olfactory functions of these insects.

When he first named a gigantic ungulate, with somewhat Dinotherium-like teeth, from the Lower Tertiaries of Patagonia, under the name of Pyrotherium, the late Dr. F. Ameghino regarded it as a proboscidean. His views have not, however, been accepted by the majority of palæontologists, and no mention of the genus is made by Dr. Andrews in his summary of the evolution of the Proboscidea in the "Guide to the Elephants in the British Museum." During a recent expedition to Patagonia, dispatched by Amherst College, Prof. F. B. Loomis obtained a couple of skulls of Pyrotherium, which he has described in a volume, published by Amherst College, under the title of "The Deseado Formation of Patagonia." He concludes that the genus is really proboscidean, but his views (which are supported by Señor C. Ameghino in *Physis* for December, 1914) are disputed in a review by Mr. R. S. Lull in vol. xxxviii., p. 482, of the *American Journal of Science*, where it is urged that the characters relied upon by Prof. Loomis are not of taxonomic value, and that Pyrotherium is not entitled to a place among the Proboscidea. The question has an important bearing, not only on the phylogeny and "radiation" of that group, but on mammalian distribution in general.

Great interest attaches to an article by Mr. A. H. Clark in Smithsonian Miscellaneous Collections, vol. lxv., No. 1, on the distribution of Peripatus and its allies, collectively constituting the group Onychophora. This group, which is apparently an ancient one, though there is no direct evidence on this point, occurs in the Malay Peninsula and Sumatra; Ceram, Papua, New Britain, Australia, Tasmania, and New Zealand; Ethiopian Africa; and Central and South America, and the West Indies. The distributional area is thus limited to countries with a mean annual temperature of from approximately 50° to 80° F.; most of the species, however, occur in countries where the mean is from 60° to 70° F. All the species are restricted to the region south of the tropic of Cancer, while the great majority are confined to the southern hemisphere, the West Indies and Central America being the only localities where an appreciable number of species occur north of the equator. The group is divided into the two families, Peripatidæ and Peripatopsidæ, and nowhere, so far as known, are species of the two families found in the same area. Moreover, the two subfamilies into which the Peripatidæ are divided are sundered by the entire breadth of the Indian Ocean. Then, again, the two subfamilies of the Peripatopsidæ inhabit separate areas in the Australasian region, one being restricted to Papua and the neighbouring islands, while the other is found in Australia, Tasmania, and New Zealand; both groups, however, co-exist in South Africa.

No. xxxix. of the Notes of the Royal Botanic Garden, Edinburgh, contains papers on some new Japanese mountain plants, by Mr. H. Takeda, an enumeration of the Chinese Astragali by Mr. N. D. Simpson, and contributions to the knowledge of the Asiatic Polypodiums by Mr. Takeda. The mountain plants come from the mountain group, Yûparodake in the island of Yezo, some 6000 ft. high, which has not been properly explored botanically before, and a great many interesting records have been obtained and new species collected, salient details of some of which are figured. Mr. Simpson's paper on a very difficult genus is of considerable value, since he has given a careful synopsis of the Chinese species, setting them out in clearly defined sections, and has assigned the specimens to their respective species. Seventeen new species, chiefly from Yunnan and Szechuan, are also described.

In the *Philippine Journal of Science* Mr. Frank G. Gates gives an account, illustrated by a map and plates, of the re-development of vegetation on Taal Volcano, a low mountain in the middle of Bombon Lake, Batangas Province, Luzon. The lake is 22 km. long by 14 km. wide, and the island is therefore not a very great distance from the surrounding shores. The devastating earthquake occurred on January 30, 1911, and the progress of the re-growth of vegetation has been carefully noted. Strand plants, *Ipomaea Pes-Caprae* and *Canavalia lineata*, first appeared, due to water transport of seeds, then grasses became established from wind-borne seeds. In contrast to Krakatoa, very few ferns have appeared, probably as only a few are found on the mainland. After the grasses came shrubs and small trees, and the latter are followed by trees and bamboos. The plants found are discussed in connection with the ecological formations in which they may be grouped.

The annual report on the Forest Administration of Southern Nigeria for the year 1913, recently received, is, like its predecessors, an interesting document, though it records much that is to be deplored. The destruction of forest which is taking place to give more land for cultivation is a very serious matter, for whole ranges of hills have been denuded of forest growth right up to their crests, and the sources of their many streams have been exposed. The result of this forest destruction will mean, not only the washing away of the soil from the slopes, but, even more important, the loss of a proper water supply to the fertile valleys. With bare hills, the rain precipitated will at once run off instead of being conserved by the forest and released gradually, and the cultivation of cacao and kola in the valleys will become impossible. The chief conservator, who has toured widely through the country, records the same tale of reckless destruction of forest on all sides. It is to be hoped that prompt action will be taken, as was done in India when roads and railways opened the country, to save the existing forest from the general wreckage and also ensure a continuous water supply.

Though it has been usual to regard the great Hawaiian earthquakes of 1868 as of volcanic origin, Mr. H. O. Wood, in a valuable paper, has recently collected evidence which seems to show that they were tectonic, rather than true volcanic, earthquakes (Bull. Seis. Soc. America, vol. iv., 1914, pp. 169–203). He points out that the most violent earthquake of the series, that of April 2, was preceded and followed by numerous accessory shocks, that it disturbed an area of about 375,000 square miles, that the depth of its origin must have been considerable, and that it gave rise to important seismic sea-waves. In all these respects, it differed from earthquakes of the ordinary volcanic type, many of which, however, are probably not *directly* connected with volcanic operations, but are due to fault-slips along radial and peripheral fractures of the volcano.

It has long been known that magnets are sometimes made to oscillate during the passage of earthquake-waves; and the phenomena, especially those observed with the Riviera earthquake of 1887, have given rise to considerable discussion. A recent memoir by Prof. H. F. Reid (Bull. Seis. Soc. America, vol. iv., 1914, pp. 204–14) ought to end the controversy. He shows that there are certain periods for horizontal and vertical disturbances that will cause marked oscillations of unifilar and bifilar magnets and magnetic balances; and that, if the periods of the earthquake-vibrations should approximate to any of these periods, they may cause the magnets to oscillate. Prof. Reid concludes that the broadening, blurring, or interruption of the magnetic trace at the time of earthquakes may be due to oscillation of the suspended magnets by purely mechanical vibrations, and does not require us to assume the existence of real magnetic forces or electric currents.

Mr. N. L. Bowen (*Amer. Journ. Sci.*, vol. xxxix., 1915, p. 175) describes and illustrates several interesting experiments which show that crystals separating from a molten silicate mixture tend to accumulate by gravitation in the lower layers of the mass. He thus gives strong support to Charles Darwin's view of gravitation as a factor in the differentiation of igneous rocks. Crystals of olivine have been gathered towards the bottom of a crucible, those in the lowest layers being smaller than those above them, since the latter have fallen through a greater depth of liquid. Both olivine and pyroxene crystals induce during cooling the formation of coats of amphibole round them. Seeing how quartz in lavas may become coated by a deposit of pyroxene, there is clearly room for further research as to these reaction-zones. The author has succeeded in separating tridymite in more highly siliceous mixtures, the crystals becoming in this case concentrated upwards by flotation.

The January issue of the Proceedings of the Academy of Sciences of Philadelphia contains a summary, in French, by Mr. Stanislas Meunier of his views with regard to the general theory of glacial phenomena and the origin of polished and striated pebbles. In many respects these views are of a distinctly revolutionary type, and subversive of current theories. Especially is this the case with regard to striated pebbles, generally held to be of glacial origin, but which, in the author's opinion, are rather the result of "subterranean denudation," as exemplified by formations in the Vosges and elsewhere. It is remarked that these polished and striated fragments are almost exclusively calcareous, and that the scratches have been made by quartzitic and other hard rocks. A portion of surface-water, it is observed, sinks into porous soil, where subterranean denudation brings these slowly moving quartz-fragments into contact with irregularly shaped *débris* of calcareous rocks, which are eventually ground down into the polished and striated pebbles hitherto regarded as affording decisive evidence of glacial action.

The replacement of limestone by hæmatite, so as to produce masses or beds of iron ore, has been long recognised. In a paper on the genesis of certain Palæozoic interbedded iron ore deposits, Mr. R. B. Earle makes a strong case for the similar replacement of sandstone by percolating ferruginous waters charged with carbon dioxide (Annals N. York Acad. Sci., vol. xxiv., p. 115). He uses the word "iron" freely in place of "iron oxide"; but we gather that the ore referred to is usually hæmatite. The Clinton formation that flanks the Appalachian Mountains includes oolitic iron ores, in which the nuclei of the oolitic grains consist of partly corroded sand-grains. The quartz can be seen in microscopic sections to be in various stages of discoloration and replacement. The crusts of ore finally protect the nucleus from complete decay. The removal of quartz from granite and its replacement by calcite has been noted in the north of Ireland; but a better parallel with the Clinton occurrences is to be found in the Karroo sandstones of the Orange Free State, as described by Prof. R. B. Young (Trans. Geol. Soc. S. Africa, vol. xvii., 1914, p. 55). Here nodules of pyrite have originated, in which the iron sulphide "is seen not only to fill the interstices between sand-grains, but also to replace the latter to a considerable extent, the metasomatic action being most intense as the centres of the nodules are approached." Felspar as well as quartz has been attacked in this case.

The Transactions of the Naturalists' Society of Kazan University contain several articles on the botany of western Siberia and the Steppes—"In the Mountains and Valleys of the Altai" (vol. xlvi., No. 1), and "Researches into the Botanical Geography of Saissan in Semipalatinsk" (vol. xliv., No. 5), by V. A. Keller, and "Botanical and Geographical Investigations in Semipalatinsk" (vol. xlv., No. 3), by V. Krüger. Both authors give lists of the plants collected, with details of the localities where they were found and their environment. They also paid close attention to the temperature of the soil during the summer months when they were at work. Mr. Keller found the absolutely lowest soil temperature in the Altai in the upper part of the forest zone, and this zone seems to be in general colder than the mountain tundra which lies at a higher elevation. In the latter region the soil was considerably warmer where lichens abounded than in the tundra of bushes and mosses. The absolutely lowest temperatures (34·3° down to freezing point) were found in July in the section of the forest zone, where the vegetation was of a character intermediate between those of sphagnum peat swamp and wet mossy forest. The highest temperature (70·5°) occurred in the stony section of the mountain steppe. Mr. Krüger also ascertained the proportion of moisture in the surface soil, and found that in the following six areas indicated by their predominant forms of vegetation—(1) *Festuca sulcata*, (2) *Artemsia pauciflora*, (3) *Atriplex canum*, (4) *Obione verrucifera*, (5) *Halicnemum strobilaceum*, (6) *Salicornea herbacea*—the percentage increased from (1) to (6). At about a foot below the surface the proportion also increased, but in a smaller ratio. The salinity of the soil was also smallest in the first and largest in the sixth area.

Discussions of the anemographic observations recorded at Port Blair and at Dhubri by Mr. W. A. Harwood are given in the Memoirs of the Indian Meteorological Department, vol. xix. In an introduction, Dr. G. T. Walker explains that the analysis of the winds at Port Blair was almost completed by Sir John Eliot prior to his death. The Port Blair discussion, which embraces the observations for ten years, September, 1894, to August, 1904, is of special interest, as it is the only purely insular and tropical station at which anemographic data are recorded in India. The position of the station is well described, and the records are said to represent correctly the winds of the surrounding portion of the Bay of Bengal. At Port Blair winds from north-easterly directions predominate from November to March, or for five months of the year, and winds from south-westerly directions predominate during the five months from May to September. In the transition months of April and October, between the monsoons, winds are very variable. The discussion of the anemograph observations recorded at Dhubri is for seven years to May, 1896. The situation of the station is given in detail, and the anemograph was mounted on a tower, 45 ft. above the ground; its exposure is said to have been excellent. The height of the instrument above the tower is not given. The predominant winds at Dhubri are said to be those up and down the Assam Valley. During November, December, and May down valley winds very largely prevail, but up valley winds are more numerous than down valley winds in February, March, July, and August. Seasonal and diurnal movements of the air are given in tabular form for both stations.

A copy of the annual report of the Board of Regents of the Smithsonian Institution, "showing the operations, expenditures, and condition of the Institution" for the year ending June 30, 1913, has been received from Washington. The volume runs to 804 pages, of which 140 are concerned with reports and proceedings. The bulk of the book consists of the general appendix which furnishes a miscellaneous selection of scientific papers, some of them original, embracing a considerable range of scientific investigation and discussion. Many of the papers are translations of contributions by distinguished foreign men of science. Among these translations may be mentioned: The reaction of the planets upon the sun, by M. P. Puiseux, astronomer at the Paris Observatory; modern ideas on the end of the world, by Prof. G. Jaumann, professor of physics at the Technical High School at Brünn; recent developments in electromagnetism, by Prof. Eugene Bloch, of the Lycée Saint Louis; oil films on water and on mercury, by Prof. H. Devaux, of Bordeaux; ripple marks, by M. Ch. Epry; the development of orchid cultivation and its bearing upon evolutionary theories, by M. J. Costantin; the problems of heredity, by Dr. E. Apert, principal at Andral Hospital, Paris; the whale fisheries of the world, by M. Charles Rabot; the earliest forms of human habitation and their relation to the general development of civilisation, by Prof. M. Hoernes; feudalism in Persia: its origin, development, and present condition, by M. J. de Morgan, of Paris; shintoism and its significance, by Mr. K. Kanokogi, of Tokyo, in *Zeitschrift für Religionspsychologie*; the economic and social *rôle* of fashion, by M. Pierre Clerget, of Lyons; and the work of J. H. Van't Hoff, by Prof. G. Bruni, of the University of Padua. As has been the case in former years, many of the articles in the appendix are illustrated by numerous beautifully executed plates.

Messrs. John Wheldon and Co., 38 Great Queen Street, Kingsway, London, W.C., have issued a catalogue of books and papers on economic botany which they have for sale. The list, which is conveniently classified, contains particulars of books on commercial plants, tropical agriculture, food plants, and many other branches of economic botany.

The following forthcoming books of science are announced by Messrs. Constable and Co., Ltd.:—"Textbook on Motor-car Engineering," by A. G. Clarke, vol. ii., Design; "Telegraph Engineering," by Dr. E. Hausmann; a new edition of "Wood Pulp," by C. F. Cross, E. J. Bevan, and R. W. Sindall. Mr. John Murray will shortly publish "Evolution and the War," by Dr. P. Chalmers Mitchell.

OUR ASTRONOMICAL COLUMN.

Comet Notes.—The Ephemeris Circular of the *Astronomische Nachrichten* (No. 482) contains the elements and ephemeris of comet Mellish (1915*a*), communicated by Dr. Fischer-Petersen. As this ephemeris differs somewhat from that given last week the new positions for the current week are as follows:—

	R.A. (true) h. m. s.	Decl. (true) ° ′	Mag.
April 22 ...	18 32 24 ...	−6 58·7 ...	7·6
24 ...	35 9 ...	7 47·2	
26 ...	37 57 ...	8 40·6 ...	7·4
28 ...	40 50 ...	9 39·5	
30 ...	18 43 48 ...	−10 44·6 ...	7·1

The comet lies towards the southern portion of the constellation of Aquila, in the neighbourhood of the stars 1, 2, and 3 Aquilæ.

The only information to hand regarding the observed return of Winnecke's comet is that mentioned in the *Morning Post* of April 15. It is stated that Dr. Thiele, of the Bergedorf Observatory, Hamburg, recorded its position on a photograph, the object being of the 16th magnitude. This comet has a period of about 5·8 years, and was first discovered in 1858. At the present return perihelion will not be reached until September, so that later the comet may be a good telescopic object.

Prof. E. C. Pickering, in *Harvard Circular*, No. 187, gives some early positions of comet 1914*e* (Campbell). This comet, as the circular states, appears to have been first seen on Thursday, September 17 (astronomical date), at one o'clock in the morning, by Mr. Leon Campbell, at the Arequipa Station of the Harvard Observatory. The comet was then visible to the naked eye. It was discovered independently a few hours later by Dr. Lunt, at the Cape Observatory, and by Mr. Westland, in New Zealand. Six photographs taken by Mr. Campbell were sent to Cambridge, and the positions have been measured and are here recorded.

The Rotation of the Solar Corona.—M. J. Bosler, in the *Comptes rendus* for April 6 (vol. clx., No. 14, p. 434), describes the result he has obtained in an investigation on the velocity of rotation of the solar corona. The experiment was made during the solar eclipse of last August, and the apparatus provided the means of photographing the whole spectrum of the corona. It was thought that the green radiation at λ5303 would prove the most satisfactory line for measurement, but its absence rendered this impossible. However, the new red ray (λ6374·3) provided the opportunity for the determination, and the result obtained is here described. The photograph secured showed two strips of spectra of the corona at the east and west limbs, and, as comparison spectra, three other strips of spectra of diffused sky light were secured symmetrically on the same plate ten minutes after the eclipse. The resulting wave-lengths of the coronal line for the east and west limbs were found to be as follows, each wave-length being the mean of five complete series of measures entirely distinct:—

East λ 6374·43 (Rowland)
West λ 6374·59 ,,

Diff. 0·16

This difference corresponds to a velocity of 3·7 kilometres, and, making a correction for the inclination of the slit to the solar equator, gives an equatorial velocity of about 3·9 kilometres per second, a value correct to about 25 to 30 per cent. In the eclipse of 1898 Prof. Campbell, using the green radiation, deduced a tangential velocity of 3·1 kilometres a second (±2 km. nearly), the diffuse nature of the radiation preventing further accuracy. M. Bosler points out that the corona moves in the same direction as the surface of the sun, and appears to rotate more quickly. The higher levels of the chromosphere show a similar tendency only to a less degree. An apparent increase in velocity with the elevation is thus proved.

THE ANNUAL OF THE BUREAU DES LONGITUDES, 1915.—The very useful annual for the current year published by the Bureau des Longitudes is as compact as ever, and contains a mine of valuable information very handy for reference. Besides the usual numerous tables useful to the astronomer, several new communications are included. Thus M. G. Bigourdan writes on the subject of the constellations, and after a brief historical sketch gives the co-ordinates of the principal stars and star charts down to 50° S. latitude. Quite a long article, devoted to stellar spectra and their classification, is written by M. A. de Gramont. The author describes Secchi's classification with illustrations of the type spectra, and then refers to more recent classifications, giving a table showing the correspondence with each other. Sir Norman Lockyer's classification is dealt with in a separate section of the article, and is compared with the Harvard College Observatory classification. A very valuable article, covering 162 pages, is that on "Methods of Examination of Mirrors and Objectives," contributed by M. Bigourdan. The article is illustrated by a large number of very useful figures, which will considerably help the reader. The preliminary chapter includes numerous historical references, and this is followed by chapters on general methods of examination, their application to all reflecting surfaces, the examination of mirrors mounted in telescopes, and, finally, a very complete account of the examination and testing of objectives.

CHINESE RECORDS OF ECLIPSES.—In the Proceedings of the Tôkyô Mathematico-Physical Society (January, 1915, vol. viii., No. 1) Messrs. Kiyotugu Hirayama and Sinkiti Ogura discuss the interesting records of early Chinese eclipses. Their working list extends from the earliest solar eclipses to those recorded in the Ch'un Ch'iu. In the case of the latter, the calculations are in progress, and are expected to be soon finished. In the present communication the general plan of the calculations consists in determining the central line and the limiting lines for each eclipse. The eclipses of Shu Ching and Shih Ching are dealt with, and diagrams are given showing some of the limits of visibility.

TEACHING OF ENGINEERING IN EVENING TECHNICAL SCHOOLS.

THE "Memorandum on the Teaching of Engineering in Evening Technical Schools" (Circular 894), recently issued by the Board of Education, is a very welcome manual of suggestions to teachers and organisers of schools which provide evening classes in mechanical and electrical engineering.

This Memorandum fills nearly sixty foolscap pages, and is divided into nine sections. An introductory section points out the limitations of part-time courses—courses intended for students whose ordinary employment occupies the greater part of their time—when compared with full-time day courses. The second section, after referring to the fact that some of the serious disadvantages which characterise part-time courses conducted in the evening may be avoided by the growing practice of holding such courses during the day (the junior employees being allowed "time off" in order to attend them), proposes to classify "a complete curriculum of evening instruction" into three stages: the junior course (fourteen to sixteen); the senior course (sixteen to eighteen or nineteen), and the advanced course (eighteen or nineteen to twenty, twenty-one, or twenty-two). Senior courses are to be of two kinds: a minor course, complete in itself, for apprentices to engineering trades; and a major course, incomplete unless it also includes an advanced course, for technical men. The third section of the Memorandum gives outlines of typical major (senior and advanced) courses in mechanical and electrical engineering, and of minor (senior only) courses in some engineering trades. After making, in the next section, some valuable suggestions upon laboratory and class instruction for adolescent evening students, the Memorandum proceeds, in the following four sections, to consider in more detail the teaching of the various subjects which constitute these outline courses. The accommodation and equipment required for the various classes of work already discussed are considered in the ninth and final section.

The Memorandum is thus concerned with all kinds of evening classes intended for persons employed in engineering work, from the apprentice who is beginning to learn a trade to the designer or manager who attends a course of evening lectures delivered by a university professor. By concentrating attention upon evening classes as such, and especially upon those classes which are primarily intended for boys and young men between sixteen and twenty-two years of age, the Board's inspectors have succeeded in producing a document which cannot fail "to assist teachers and organisers to mark out for themselves the schemes of instruction best suited to the conditions of their classes." But this very concentration, to which the Memorandum owes much of its usefulness, will disappoint education committees or directors of education who look to find in it some treatment of the wider educational and economic problems of engineering training, such as the following:—The selection, on democratic lines, of the most suitable boys for each different type of training which should be provided for the different positions in engineering industry; the respective parts to be played, in the preparatory (full-time) training of engineers, by the elementary school and the junior technical school, the lower secondary school and the senior technical school, and the higher secondary school and the university or technical college; the point at which works training should begin; the co-ordination of practical experience in the shops with instruction in classes inside the works and with outside schools and colleges; and, more generally, the effective co-operation between engineering firms and education authorities in establishing and administering schemes for the advancement of apprentices.

Perhaps the most important feature of the Memorandum is the distinction which it draws between the major and the minor course. Industrial training has suffered hitherto from a lack of proper appreciation of the differences between the training required by the future artisan (or "tradesman") on the one hand, and the future "technical" man (whether designer, manager, or commercial representative) on the other. The distinction now drawn does not, however, go deep enough. The Memorandum does not sufficiently discourage the prevailing notion that the ideal evening student first enters evening classes at fourteen, and continues to attend such classes for seven years. Thus, instead of insisting that the technical student should remain at a secondary school until he is at least sixteen, and then, perhaps, enter his major (senior) course when he enters works, the Memorandum contemplates that the technical student and the trade student shall both follow the same junior (evening) course from fourteen to sixteen. It would surely be better that the trade student's own minor course should begin at fourteen instead of at sixteen, and attract him, by its special adaptation to the circumstances of his particular trade, from the moment when he leaves his day school. Moreover, since the trade student will as a rule have less opportunity for general reading in later life, his minor course might well include some "citizenship" subjects, such as industrial history considered at first from the point of view of his particular trade.

More than half of the Memorandum is devoted to "outlines of work" for various recommended courses. This portion is full of most useful suggestions. Some, however, are open to objection, or, at least, to criticism. Thus there is a curious confusion between *weight* and *mass* on page 20 ("$g \times$ force $=$ mass $\times$ linear acceleration," which would make g a pure number, independent of the system of units employed). It is also doubtful whether the conception of "work" is really so difficult as to justify the suggested postponement of its introduction until the second year of the senior course. Again, the four years' (major) course in mathematics outlined in the Memorandum might with advantage be less "practical" in its first two years, during which some time might well be found for geometry.

ENGLISH MATHEMATICS.

The *Mathematical Gazette* has recently published a translation of an address delivered by Prof. Gino Loria to the International Congress of Historical Studies. This is a well-proportioned and detached estimate of the main contributions of England to the body of mathematical science, from the earliest available records to the present time. An important suggestion is made that it may be possible to find in some of our libraries manuscript works by some of those early writers who, unlike ourselves, did not hasten to publish their discoveries, and were often surprised by death. In this connection the names of Bradwardine, Richard of Wallingford, John Maudith, and Tonstall are mentioned. Another note is that James Gregory made lengthy stays in Italy, and was therefore probably acquainted with the work of Galileo; so the question arises how far Newton may have been influenced by the achievements of the great Italian philosopher. Prof. Loria suggests inquiry about this as an important piece of research.

Prof. Loria emphasises, with justice, the fact that the renascence of English mathematics in the nineteenth century coincided with a better knowledge and appreciation of work being done abroad. The greatness of Newton, like that of Euclid and Archimedes, had a sort of benumbing effect upon his successors, and even contemporaries; although, of course, there are exceptions, like Maclaurin and Brook Taylor and Waring. It is also pointed out that even now there are certain branches of mathematics which Englishmen persistently ignore, or else treat by obsolete and clumsy methods. The example given is descriptive geometry; and it is noted that Brook Taylor laid down the principles of this subject in a way perfectly analogous to that adopted long afterwards, and independently, by Fiedler. It is not stated by Prof. Loria, but it is a fact that most of our text-books on descriptive geometry are simply contemptible, from a scientific point of view, and not to be compared with Fiedler's treatise, or the classic work of Monge, which does in the main follow the lines of what we call descriptive geometry, in the restricted sense of orthogonal projection.

Even able students who use these books, and attain great practical efficiency, have no conception at all of the subject as a whole, and are baffled by the simplest problems about traces of lines and planes. So far as we know, there is only one good treatise on descriptive geometry in the English language, and that is in the "Penny Cyclopædia," where so many other treasures have been buried and forgotten. This leads to the remark that Prof. Loria has a proper appreciation of the works of De Morgan, and laments that they are so inaccessible; with this sentiment we cordially agree.

An Italian is as likely as anyone to sympathise with English modes of thought; so any conclusion drawn from this address is likely to be flattering rather than the reverse. We must remember, too, that, when we speak of English mathematicians, we are apt to include such men as Maclaurin, Rowan Hamilton, and Sylvester, who were not Englishmen at all. But even in this inclusive sense of the term "English" one cannot but feel that Continental opinion about English mathematics is almost bound to be analogous to that about English literature in general. Newton *is* English, and, like Shakespeare, or Dante, or Goethe, incomparable; but we have lesser men, of a more distinctly national type, who may, perhaps, be more justly appreciated at home than abroad. As an example, we may instance W. H. Fox Talbot, now only vaguely remembered in connection with photography. As a mathematician he is, of course, not to be compared with Abel; nevertheless he did investigate some cases of Abel's theorem in a very instructive and fundamental way, implicitly showing that the theorem is really a deduction from the known facts about symmetric functions of the roots of an equation, and the elementary theory of partial fractions. We are inclined to believe that the simplest proof of Abel's theorem will ultimately follow the lines that Talbot has indicated.

There are many points in the address to which we cannot refer; but one that deserves mention is that Newton is reported to have said that the style of the ancient geometers is the only one appropriate to any mathematical treatise worthy of the name. Judging by the "Principia," it is probable that this story is authentic.

G. B. M.

PUBLIC HEALTH.

The Medical Officer's Supplement to the forty-third Annual Report of the Local Government Board for 1913–14 (Cd. 7612, price 1*s*. 11*d*.), while it deals mainly with matters primarily of medical interest, of necessity includes within its scope much that is of value to all scientific minds.

The question of infant mortality occupies a prominent place, and one notes with satisfaction that the general trend of the curve continues in a downward direction. Greater provision is likely to be made in the near future for the care of expectant mothers, and the official recognition of an ante-natal state, though somewhat belated, is none the less welcome. Much good work has been done by voluntary agencies in the past, and the linking up of this with the various organisations dealing with child welfare must inevitably tend to a healthier future race.

Some interesting figures are given regarding vaccination returns. It appears that in England and Wales as a whole one-half of the children whose births were registered in 1912 have been vaccinated, and nearly one-third have been exempted from vaccination by statutory declaration of conscientious objection. When compared with the returns for 1911, these figures show a percentage reduction of 52·3 to 50·1 in the proportion of children born who are vaccinated. The percentage of children born who were exempted under certificate of conscientious objection increased from 28·5 to 32·1.

Inquiries have been made regarding certain outbreaks of enteric fever supposedly due to the consumption of infected shell-fish. The medical officer of health of a seaport town has repeatedly referred to the danger incurred by persons in collecting shellfish of all sorts from areas obviously contaminated with sewage. While it is difficult in most cases to prove conclusively that an epidemic owes its origin to such a practice, yet, when local authorities have acted as if such were undoubtedly the case, the wisdom of such action has been abundantly shown by the nonrecurrence of the disease.

Progress is constantly being made towards securing purer and more wholesome food for consumption in this country. A careful watch has to be kept at the various ports of entry to prevent so far as possible the import of unsound and even poisonous material. As an instance of what is continually happening it will suffice to quote the following occurrence. During the unloading of a cargo of sugar in the Port of London it was noticed that some of the bags containing the sugar were covered with borax, which had been carried in the same hold and had become loose during the voyage. Samples of this powder were taken, and analysis showed them to contain arsenic in considerable quantities. The whole of the sugar was rebagged, and that portion of it that had already been sent out was recalled for suitable treatment under supervision.

The effect of certain types of waters on lead has again been brought into prominence by an outbreak, extensive though mild, of lead poisoning in an urban district in Yorkshire. The waters most liable to act in this way are acid, peaty supplies, and it is even asserted as conceivable that the treatment applied with a view of destroying the plumbo-solvent properties of the water may tend in some way to increase the ability of the water to erode the lead. At all events, further investigation is being made, as the case in point has proved a very difficult one to deal with.

More research has been conducted on the subject of ferro-silicon with special reference to possible danger arising from its transport and storage. This substance, of certain percentage compositions, is liable to disintegration in the presence of moisture, and poisonous gases are given off in quantity sufficient to produce fatal results in human beings. It is suggested that liability to spontaneous disintegration with evolution of poisonous gases may be related to the amount of aluminium present in the ferro-silicon. Further reports are now issued on ferro-chrome and other ferro-alloys, with special reference to aluminium content.

The work of Prof. Leonard Hill on the effect of open-air and wind in the metabolism of man is referred to. He points out that the physical qualities of the air—heat, moisture, and movement—are of paramount importance to health. The stimulating effect of cool and variable breezes acting on the skin leads to improved health, while a stagnant, windless, over-warm atmosphere tends to depression and diminished vitality. Two new instruments are described—the kata-thermometer and the caleometer—which enable the rate of cooling of the body and the variability of the rate to be measured (see p. 205 of this issue of NATURE). Prof. Hill's researches on the physical condition of the atmosphere have done much to elucidate the problem of "stuffiness," to which so many ailments are undoubtedly due.

THE CARNEGIE INSTITUTION OF WASHINGTON AND SCIENTIFIC RESEARCH.

THE Carnegie Institution of Washington was founded by Mr. Carnegie in 1902, when he gave to a board of trustees an endowment of 2,000,000*l.*, to which he added 400,000*l.* in 1907, and a further 2,000,000*l.* in 1911. The articles of incorporation of the institution declare "that the objects of the corporation shall be to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind," and already, as the annual reports of the president and the directors of the various departments show, the objects of the institution are being fulfilled admirably.

The trustees have inaugurated and developed three principal agencies to forward the aims of the institution. In the first place, the departments of research attack problems requiring the collaboration of several investigators, special equipment, and continuous effort. A second agency provides means to enable individuals to complete investigations requiring less collaboration and simpler apparatus; while a third division deals with the publication of the results obtained as the result of the work of the first two agencies.

The reports by the president, the directors of the various departments of research, and the executive committee, contained in the 1914 Year Book, recently received, give full particulars of the financial resources of the institution, and of the activities of its different departments, during the year under review. The Year Book provides convincing evidence of the success of the trustees of the institution in their endeavours to encourage and advance scientific research.

The following table shows the amounts of the grants made by the trustees for the current year, and the purposes to which they are being devoted:—

	£
Administration	10,000
Publication	12,000
Division of Publications	2,000
Departments of Research	138,462
Minor Grants	21,860
Index Medicus	2,700
Insurance Fund	5,000
Reserve Fund	50,000
Total	242,022

The next table shows the departments of scientific investigation to which the larger grants were made for the financial year 1913–14, and the amounts of these grants:—

	£
Department of Botanical Research ...	8,428
Department of Economics and Sociology	1,000
Department of Experimental Evolution ...	12,696
Geophysical Laboratory	17,100
Department of Historical Research ...	6,220
Department of Marine Biology	3,830
Department of Meridian Astronomy ...	5,036
Nutrition Laboratory	9,159
Division of Publications	2,000
Solar Observatory	44,178
Department of Terrestrial Magnetism ...	31,481
Researches in Embryology	5,380
Total	146,508

The following extracts from the *résumé* of the investigations of the year included in the report of the president, Dr. R. S. Woodward, will serve to indicate the nature and extent of the scientific work accomplished during the year.

Although the greater part of the work of the Department of Botanical Research is carried on at its principal laboratory at Tucson, Arizona, it is essential to a comprehensive study of desert plant life to explore distant as well as adjacent arid regions. Thus, having published during the past year the results of an elaborate investigation of the region of the Salton Sea, the department is now turning attention to similar desert basins, of which there are several in the Western States that have been studied hitherto in their geological rather than botanical aspects. These researches are entailing also many applications of the allied physical sciences not heretofore invoked to any marked extent in aid of botanical science. Hence there results properly a diversity of work quite beyond the implications of botany in the earlier, but now quite too narrow, sense of the word. The facilities of the Desert Laboratory have been enlarged during the year by the completion and equipment of a specially designed small building for studies in phyto-chemistry, which has been proved to play a highly significant *rôle* in desert life.

The observational, statistical, and physical methods applied by the Department of Experimental Evolution are constantly adding to the sum of facts and of inductions essential to advances in biological knowledge. The range of application extends from the lowest organisms, like fungi, up to the highest, as typified in the race to which the investigators themselves belong. Thus, during the past year, observations and experiments have been made on mucors, plants, pigeons, poultry, and seeds, while the director has continued his fruitful statistical studies in the relatively new field of departures from normality in mankind. The variety of agencies employed in this wide range of inquiry now includes a permanent staff of about twenty members and a physical equipment enlarged during the year by the completion of an additional laboratory and a power-house. Early in the year the facilities of the department were increased by the successful transfer, from Chicago to Cold Spring Harbour, of the remarkable collection of pedigree pigeons recently acquired by the institution from the estate of Prof. C. O. Whitman.

An instructive example of the favourable progress, which may be confidently expected in any field of research when entered by an adequately manned and equipped department devoted solely thereto, is afforded by the experience of the Geophysical Laboratory. In less than a decade this establishment has not only accomplished the formidable task of constructing the necessary apparatus and of preparing many of the pure minerals concerned, but has already begun the processes of analysis and synthesis which are leading to extensive additions to our knowledge of rock and mineral formations found in the earth's crust. Among the problems under investigation, one of immediate economic as well as of great theoretical interest may be cited here by reason especially of the fact that funds for its execution have been supplied by industrial sources; this is the problem of the "secondary enrichment of copper ores," and the success attained in its treatment demonstrates the practicability of advantageous co-operation between the laboratory and industrial organisations without restriction to scientific procedure and publicity. The section of the director's report devoted to this subject should be of special interest to geologists and to mining engineers as well as to copper-mining industries. A more comprehensive idea of the productive activities of the laboratory may be gained from its publications, which embrace forty-nine titles of papers which have appeared in current journals or are in the press, many of them having been published in German as well as in English.

In accordance with plans recommended by the director of the Department of Marine Biology and approved by the trustees in 1912, an expedition to Torres Straits, Australia, was undertaken in the latter part of the preceding year. Early in September, 1913, the director and six collaborators arrived at Thursday Island in the Straits, expecting to use this relatively accessible island as a base of explorations; but it was soon found advantageous to proceed to Maër Island, one of the Murray group, about 120 miles east-north-east, and near to the outer limit of the Great Barrier Reef. Here a temporary laboratory was set up in the local courthouse and jail, generously placed at Dr. Mayer's disposal by the British authorities. The region proved to be one rich in coral reefs and in marine fauna for the work contemplated. Observations and experiments securing gratifying results were carried out during the months of September and October, 1913. In addition to the critical data secured by Dr. Mayer with respect to the corals about Maër Island, for comparison especially with corresponding data from the corals of Florida waters, observations and materials for important contributions to zoology were collected by each of his collaborators. On returning to America from the southern hemisphere, the director was engaged, during April and May, in two minor expeditions with the departmental vessel *Anton Dohrn*. The first of these was in aid of the researches of Dr. Paul Bartsch, on cerions, and required a cruise along the Florida Keys from Miami to Tortugas and return. The second expedition was in aid especially of Dr. T. W. Vaughan, long associated with the department in studies of corals and related deposits, and required a cruise from Miami, Florida, to the Bahamas and return. It appears that during its first decade forty-nine investigators have made use of the Tortugas Laboratory, twenty-eight of these having returned two or more times, making a total of 108 visits to this relatively inaccessible centre of research. Of the publications emanating from the department, sixty have been published by the institution, while upwards of forty have been published under other auspices.

The activities of the Department of Meridian Astrometry are concentrated on the derivation of stellar positions for the comprehensive catalogue in preparation, on supplementary measurements of stellar co-ordinates with the meridian circle of the Dudley Observatory, and on investigations of residual stellar motions. The latter have now become the most important element in the definition of stellar positions by reason of the extraordinary recent progress in sidereal astronomy, to which the department has contributed in large degree. Thus, along with the formidable computations required by the large mass of observations made by the department at San Luis, Argentina, researches are simultaneously continued on the problems of star-drift, including the speed and direction of motion of our solar system. In the meantime, the catalogue is progressing favourably and some portions of the observatory list of miscellaneous stars are approaching completion, although cloudiness during the past two winters has interfered with this part of the departmental programme. In the meantime, also, the manuscript of the zone catalogue of stars the positions of which were measured at the observatory during the years 1896 to 1900, is undergoing the final process of comparison and checking preparatory to publication.

The anticipations of a specially favourable environment, which were entertained when the Nutrition Laboratory was located in Boston near the Harvard Medical School and near several existing and projected hospitals, are now fully realised; and it would appear that the laboratory is reciprocally advantageous to the several establishments with which it is in immediate contact. Indeed, with this, as with all other departments of research founded by the institution, the only fears to be entertained seriously are those due to increasing capacity for usefulness and scientific progress, since such capacity tends quite properly to grow faster than the institution's income warrants.

Improvements have been made in the laboratory itself, and several additions to equipment have been installed. These latter include new respiration apparatus for studies of metabolism in muscular work of men and of small animals, a reconstruction of an earlier form of bed calorimeter, and additional apparatus for photo-electric registration of physiological action in subjects under observation, whether near by or at a distance.

As indicated in previous reports, the laboratory and its work are subjects of international as well as national interest, and many co-operative efforts are arising therefrom. Among the researches in progress by the laboratory staff, attention may be directed particularly to "The gaseous metabolism of infants with special reference to its relation to pulse-rate and muscular activity," by Francis G. Benedict and Fritz B. Talbot, and to "A study of prolonged fasting," by Francis G. Benedict.

The extensive operations of the Department of Terrestrial Magnetism on the oceans and in foreign countries have been adequately supplemented during the year by the new departmental laboratory, the completion and occupation of which took place nearly simultaneously with the beginning of the second decade of the department's existence. This laboratory and its site provide greatly enlarged facilities for research, as well as unsurpassed quarters for the resident departmental staff.

Near the end of the preceding year the non-magnetic ship *Carnegie* returned to New York City, where she underwent such extensive repairs as are always required by wooden vessels after long cruises in tropical waters. After refitting, she left New York, June 8, 1914, for a cruise in the North Atlantic. In this, the third of her expeditions, she traversed about 10,600 miles, making a first stop at Hammerfest, Norway, July 3, reaching the high latitude 79° 52′ off the north-west coast of Spitsbergen, touching at Reykjavik, Iceland, August 24, and returning to the base station at Greenport, Long Island, October 9, and to Brooklyn, New York, October 21. During this cruise the *Carnegie* was in command of Mr. J. P. Ault. She is now being refitted for a longer cruise during 1915–16, in southern latitudes (50° to 75°), where magnetic observations require supplementing.

An attempt at an ocean expedition into Hudson Bay was made under the charge of Mr. W. J. Peters during the past summer, but on account of unusual obstacles from ice this proved only partly successful. Entrance into the Bay with the auxiliary schooner *George B. Cluett*, chartered for this purpose from the Grenfell Association, was blocked until September 2, leaving less than a month's time available for surveys.

Determinations of magnetic elements on land have been continued in six parts of Africa, in as many States of South America, and in Australia, bringing the surveys of all these continental areas to a well-advanced stage.

With the end of the current year the Mount Wilson Solar Observatory, like most other departments of the institution, will have completed a first decade of its history. Quite appropriately, this establishment was founded at an epoch of maximum sun-spots, and a marked increase in solar activity during the past year furnishes similarly auspicious conditions for entrance into a second decade of research. But much more auspicious conditions are found in the extensive experience and in the effective equipment acquired along with the capital progress attained during this first decade. The most sanguine astronomer would have hesitated at the earlier epoch to predict that these latter conditions could be realised at the present epoch. Herein also is found a signal illustration of the superior effectiveness of establishments primarily designed for and exclusively devoted to research as compared with establishments in which research is a matter of secondary interest.

Progress in construction of the 100-inch telescope has been made as rapidly as could be expected in so formidable an undertaking. The delicate optical task of shaping the 100-inch mirror has been brought successfully by Mr. Ritchey to the stage of sphericity which precedes the final state of parabolisation. The difficulties due to distortion of the mass of the disc, referred to in previous reports, have been overcome, and other obstacles due to temperature inequalities in the optical room are likewise yielding to appropriate precautions. In the meantime, the foundations for this telescope have been completed, and the mounting and dome are expected to be ready for erection during the coming year. Several smaller parts and accessories for this instrument, requiring special exactness, are under construction at the shops of the observatory in Pasadena. Many additions and improvements in the apparatus already installed at the observatory have been made. The 60-foot tower telescope particularly, which was originally cheaply constructed in order to test the possible advantages of such a departure from earlier forms of telescopes, has been put in a state of efficiency comparable with that of the 150-foot tower telescope, leaving the latter free for the uses to which it is specially devoted. In these general improvements much attention has been given to rendering the plant on Mount Wilson more nearly fireproof. The mountain road has been repaired, widened, and strengthened in many parts in anticipation of the heavy traffic essential to transportation of the 100-inch telescope to its destination.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Adams prize for 1913–14 has been awarded to Mr. G. I. Taylor, Smith's Prizeman in 1910. The subject selected was "The phenomena of the disturbed motion of fluids, including the resistances encountered by bodies moving through them." The value of the prize is about 250*l*.

It is stated in *Science* that by the will of General Brayton Ives, of New York City, the largest part of his estate is bequeathed to Yale University for its general purposes. The value of the bequest is estimated at from 150,000*l.* to 300,000*l.*

We learn from *Science* that through the efforts of Dr. Ralph Arnold, and other alumni of the department of geology and mining, Stanford University has just added to its collections the working library and material of the late Prof. H. Hemphill, of Los Angeles. The collection contains between 8000 and 9000 specimens of shells and 150 volumes. The material is of great importance in the study of the Tertiary geology of the Pacific coast, and especially of the geology of the petroleum deposits of California.

The March number of the *Nature-Study Review* (Ithaca, N.Y.), the official organ of the American Nature-Study Society, is devoted to an elaborate prospectus of courses in nature-study for elementary schools. It has been prepared by Mr. G. H. Travers and Miss H. M. Reynolds, of the Minnesota State Normal School, and it is copyright. The authors take a big view of their subject, and emphasise "the æsthetic, the social, the economic, and the hygienic" aims of nature-study. (The old-fashioned teacher will rather miss the intellectual aim!) To help the pupils to enjoy the world they live in, and to acquaint them with the useful and injurious forms of life, these we understand as the æsthetic and economic aims, but the social aim, so far as explained, seems to us far-fetched, and the hygienic aim is lugged in by sheer force. The "disciplinary theory" of training the powers of observation, memory, reasoning, and imagination must be given up, we are told, for the researches of modern psychology have shown it to be unsound. But it seems to reappear under another name. To more purpose, as it seems to us, the authors emphasise that the nature-study should deal with the material available in the child's environment, which in urban conditions requires to be enlarged artificially. The starting point should always be in the child's experience, and the material should be of interest or capable of becoming of interest to the child. Each study should concern itself with a child's problem, and the child should be guided to solve it. And the solution should mean something in the life of the child. "If the problem does not seem to allow of any application, we may well inquire whether the problem is really worth while." This may be pushed too far, for a stimulated imagination may be a great gain and a search for applications a bore. The graded outlines of courses are carefully thought out, and the general arrangement—following the seasons—is admirable. Teachers will find the outlines very suggestive and the introductory essay very provocative. We would particularly commend the consistent way in which the authors have sought to get at the child's point of view, and to keep to the Socratic method, not in the letter alone, but also in the spirit.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 25.—Sir William Crookes, president, in the chair.—Prof. B. **Moore**: The production of growths or deposits in meta-stable inorganic hydrosols.—Prof. B. **Moore** and W. G. **Evans**: Forms of growth resembling living organisms and their products slowly deposited from meta-stable solutions of inorganic colloids.—H. **Onslow**: A contribution to our knowledge of the chemistry of coat-colour in animals and of dominant and recessive whiteness.This research was undertaken in order to discover a chemical method of differentiating the two similar forms of white animals known as dominant whites and recessive whites, or albinos. Hitherto this has only been possible by observing their genetic behaviour. Dark animal pigments are believed to result from the oxidation of a colourless chromogen by an oxydase. The skins of young black rabbits were found to yield a tyrosinase which converted tyrosine to a melanin. By means of this tyrosinase it was possible to test extracts from white rabbits of both types. Briefly, extracts from dominant whites contained an anti-oxydase which inhibited the tyrosinase of the black rabbit extracts. Extracts from albinos, on the other hand, had no inhibiting influence, and were themselves incapable of producing any pigment. The anti-oxydase was also found in those white parts of rabbits which are dominant to colour, such as the white bellies of the wild rabbit and of the yellow rabbit carrying agouti. These results tend to confirm the Mendelian view that dominant whiteness is caused by a factor which inhibits the pigment-producing mechanism if present, and that albinism results from the partial or total absence of the factors necessary for the development of pigment. The experiments also revealed facts which suggest that the difference between pigments producing black, chocolate, and yellow hairs is quantitative rather than qualitative, for, after extraction, the pigments in all three colours appear identical. That variation in colour is a structural modification is supported by the fact that dilute colours, such as blue, are caused by a lack of pigment in the cortex. In the corresponding intense colours, such as black, pigment being present in the cortex, the white light reflected from the vacuoles is absorbed, thus deepening the colour.

Paris.

Academy of Sciences, April 12.—M. Ed. Perrier in the chair.—E. **Guyou**: Remarks on the *Extrait de la Connaissance des Temps* for 1916. An account of the modifications introduced with the view of shortening and facilitating nautical calculations.—A. **Müntz** and E. **Lainé**: Study of the material brought down by watercourses in the Alps and Pyrenees. Determinations of the quantities of material carried by the principal watercourses in the Alps and Pyrenees. The erosion is much more intense in certain recent formations. The agricultural value of the deposits has still to be examined.—M. de **Forcrand**: A hydrate of hydrogen arsenide. The hydrate $AsH_3,6H_2O$ has been isolated and determinations made of its dissociation pressures at temperatures from 0° C. to 25° C. From these data, with the aid of Clapeyron's equation, the heat of formation has been found to be 17·75 calories. Comparisons are given for analogous data for the hydrogen compounds of sulphur, phosphorus, and selenium.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1914. Observations were made of sixty-seven days, and the results are given in three tables showing the number of spots, the distribution of the spots in latitude, and the distribution of the faculæ in latitude.—S. **Chevalier**: The effect of atmospheric dispersion on the diameter of photographed celestial objects. Photographs of the sun and of Jupiter show that the effect of atmospheric dispersion on the diameter of a photographed celestial body depends very slightly on the brightness of the body or on the sensibility of the plates.—Ernest **Esclangon**: The limited integrals of a linear differential equation.—Ph. **Flajolet**: Perturbations of the magnetic declination at Lyons (St. Genis Laval) during the third quarter of 1914.—M. **Lubimenko**: Some experiments on the antioxydase of tomato fruits. Details are given of a method for estimating the amount of peroxydase in the tomato, and this method was applied to determining the proportions of peroxydase during the different stages of the ripening of the fruit. From the results obtained, it is concluded that the tissue of the tomato contains an enzyme which paralyses the oxidising action of the peroxydase. This is provisionally termed antiperoxydase, and it is much more sensitive than the peroxydase to the influence of antiseptics. Even toluene destroys it fairly rapidly. The relations between these two enzymes during the ripening of the fruit is discussed.—A. **Jungelson**: Chemical intoxication and mutation of maize. Studies in the variations produced by treating the seed with a solution of copper sulphate.—H. **Vincent** and M. **Gaillard**: The purification of drinking water with calcium hypochlorite. Compressed tabloids of 0·015 gram calcium hypochlorite with 0·08 gram salt are used. These contain 3·5 mgr. of active chlorine, and one is capable of sterilising a litre of water in about twenty minutes. There is no appreciable taste. Bacteriological experiments are given showing the removal of pathogenic bacteria.—J. **Vallot**: An installation permitting the application of intensive heliotherapy, in winter, to wounded and military convalescents.—MM. **Hirtz** and **Gallot**: A new radioscopic method for the determination of the depth of a foreign body in the organism.

BOOKS RECEIVED.

Year Book of the Royal Society of London. Pp. 250. (London: Harrison and Sons.) 5*s.*

Imperial University of Tokyo. Calendar 2573-2574. (Tokyo: Z. P. Maruya and Co.)

Royal Societies Club. Founded A.D. 1894. Foundation and Objects. Rules and By-Laws. List of Members. Pp. 354. (London.)

Practical Irrigation and Pumping. By B. P. Fleming. Pp. xvi+226. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s.* 6*d.* net.

The Design of Steam Boilers and Pressure Vessels. By Prof. G. B. Haven and G. W. Swett. Pp. vii+416. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s.* 6*d.* net.

Electrical Engineering. By Dr. T. C. Baillie. Vol. i., Introductory. Pp. vii+236. (Cambridge: At the University Press.) 5*s.* net.

DIARY OF SOCIETIES.

THURSDAY, APRIL 22.

ROYAL SOCIETY, at 4.30.—Deep Water Waves, Progressive or Stationary, to the Third Order of Approximation: Lord Rayleigh.—A Chemically Active Modification of Nitrogen, produced by the Electric Discharge. VI.: Hon. R. J. Strutt.—The Difference between the Magnetic Diurnal Variations on Ordinary and Quiet Days at Kew Observatory: Dr. C. Chree.—The Effects of Different Gases on the Electron Emission from Glowing Solids: F. Horton.—Heats of Dilution of Concentrated Solutions: W. S. Tucker.—The Origin of the "4686" Series: T. R. Merton.

ROYAL INSTITUTION, at 3.—The System of the Stars: The Stellar System in Motion: Prof. A. S. Eddington.

FRIDAY, APRIL 23.

ROYAL INSTITUTION, at 9.—Military Hygiene and the War: Major P. S. Lelean.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

PHYSICAL SOCIETY, at 5.—The Theories of Voigt and Everett Regarding the Origin of Combination Tones: Prof. W. B. Morton and Miss Mary Darragh.—Experiments on Condensation Nuclei Produced in Gases by Ultra-Violet Light: Miss Maud Saltmarsh.—The Self-Induction of Solenoids of Appreciable Winding Depth: S. Butterworth.

SATURDAY, APRIL 24.

ROYAL INSTITUTION, at 3.—Modern Artillery: Lieut.-Col. A. G. Hadcock.

MONDAY, APRIL 26.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Geography of the War Theatre in the Near East: D. G. Hogarth.

ROYAL SOCIETY OF ARTS, at 8.—Foodstuffs: Dr. D. Sommerville.

INSTITUTE OF ACTUARIES, at 5.—The New National Life Tables: G. King.

TUESDAY, APRIL 27.

ROYAL INSTITUTION, at 3.—The War on Belgian Architecture: Banister Fletcher.

ZOOLOGICAL SOCIETY, at 5.30.—White Collar Mendelising in Hybrid Pheasants: Mrs. Rose Haig Thomas.—Two New Tree-Frogs from Sierra Leone, recently Living in the Society's Gardens: E. G. Boulenger.—The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Part II.: E. Heron-Allen and A. Earland.

ILLUMINATING ENGINEERING SOCIETY at 8.—Visibility: its Practical Aspects: C. C. Paterson and B. P. Dudding.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting.

WEDNESDAY, APRIL 28.

ROYAL SOCIETY OF ARTS, at 8.—The Utilisation of Solar Energy: A. S. E. Ackermann.

INSTITUTION OF ELECTRICAL ENGINEERS, at 7.45 (Students' Section).—Annual General Meeting.

GEOLOGICAL SOCIETY, at 8.—A Composite Gneiss near Barna (County of Galway): Prof. Grenville A. J. Cole.—Further Work on the Igneous Rocks associated with the Carboniferous Limestone of the Bristol District: Prof. S. H. Reynolds.

THURSDAY, APRIL 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Transmission of Infra-red Rays by the Media of the Eye, the Transmission of Radiant Energy by Crookes's and other Glasses, and the Radiation from various Light Sources: H. Hartridge and A. V. Hill.—Surface Tension and Ferment Action: E. Beard and W. Cramer.—Surface Tension as a Factor controlling all Metabolism: W. Cramer.

ROYAL INSTITUTION, at 3.—Advances in General Physics: Prof. A. W. Porter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Bombay Hydro-Electric Scheme: A. Dickinson.

FRIDAY, APRIL 30.

ROYAL INSTITUTION, at 9.—Emulsions and Emulsifications: Prof. F. G. Donnan.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Oil Well Engineering: W. Calder.

SATURDAY, MAY 1.

ROYAL INSTITUTION, at 3.—Photo-Electricity: Prof. J. A. Fleming.

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THURSDAY, APRIL 29, 1915.

THE VALUE OF THE RARER ELEMENTS.

The Rare Earths: their Occurrence, Chemistry, and Technology. By S. I. Levy. Pp. xiv + 345. (London: Edward Arnold, 1915.) Price 10s. 6d. net.

THE rapidly-growing importance of the rarer elements in both theoretical and technical directions makes the above volume a welcome addition to English chemical literature. Except for Browning's "Rarer Elements," there is little of importance to turn to for information since the well-known "Terres rares" of P. Truchot, published in 1898. The valuable researches of Urbain have removed much of the obscurity that at one time surrounded many members of the yttria group, and has demonstrated the complexity of several that had been thought to be elementary, and quite recently an exhaustive study of the very rare earth scandia by Sir William Crookes has directed attention to this somewhat neglected branch of science.

The title of the present work is rather misleading, for the author deals not only with the rare earths proper, bodies that have always been a perplexity to both the chemist and the theorist, to the former on account of the extreme difficulty that attends their separation and isolation (they have a provoking habit of often turning out to be complex even after their isolation) and to the latter on account of the hopelessness of finding a rational place for them in any of the periodic classifications that have appeared since the original work of Newlands and Mendeléeff. The author also discusses the elements zirconium, thorium, uranium, titanium, the incandescent mantle industry, and the manufacture of artificial silk! These latter are of great interest and importance, but one would scarcely expect to find them in a book under the title of "The Rare Earths."

The book opens with an interesting and suggestive introduction by Sir William Crookes, whose work on rare earths is well known, his numerous researches in this field extending over the last thirty-five years. His remarks refer chiefly to the closely allied elements of the cerium and yttrium groups, and with his characteristic forethought he states his conviction that by following the study of these bodies to their utmost limits "we may arrive at the explanation of what the chemical elements really are, and how they originated, and discover the reasons for their properties and mutual reactions."

The work is divided into three parts: The occurrence of the rare earths; the chemistry of the elements; and the technology of the elements. Each section is treated in detail, and contains a large amount of information, showing that the author has a thoroughly practical knowledge of his subject.

To have at hand in one volume such a store of mineralogical, chemical, and technical detail is in itself a great boon, and the work is likely to become a standard of reference.

In the chapter which deals with the rare minerals a somewhat novel classification is adopted "for the sake of convenience," and an alphabetical list is given of those minerals which contain the yttrium and cerium groups as well as titanium, zirconium, thorium, scandium, etc.; the list is said to include all but a few unimportant members of this class; of these the larger number, printed in heavy type, are fully discussed in a later section. No mention is made of carnotite, the hydrated vanadate of uranium and potassium that has recently come into prominence as a source of radium, nor of the brown wükite that occurs with the black variety in Finland. As a whole, however, the list is a valuable one; it gives the name, composition, specific gravity, hardness, etc., of some 150 minerals that could otherwise only be found by lengthy search in recent mineralogical literature.

The next section, occupying some sixty pages, discusses the minerals in detail, and contains an account of the interesting mineral thorianite, from Ceylon, containing 55—79 per cent. thoria and a considerable amount of helium from which radio-thorium has been prepared by Hahn; also the recently-discovered mineral thortveitite containing 37 per cent. of scandia.

Prominence is given to the thorium and cerium minerals on account of their bearing upon the mantle industry; in this connection the chapters on the monazite sands is of great practical value, although carrying as little as 2 per cent. of monazite, the Brazilian deposits are of enormous extent and have become the chief source of the thoria that is needed for the mantle industry. Besides the Brazilian deposits, monazite occurs in quantity in Canada, India, South Africa, and in North Carolina, where in 1906 the material was successfully worked by the British Monazite Company, representing the South Metropolitan Gas Company, of London. At this juncture, however, the price of thorium nitrate was suddenly lowered 50 per cent. by the German syndicate which largely controlled the Brazilian output; this caused the British company to cease operations, which have not been resumed. The American company working upon the same material shared a like

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fate, and the German syndicate, together with the Austrian Welsbach Company, now practically meet the world's demand. What effect recent events will have upon this state of affairs remains to be seen, but it looks as if great opportunities are opening out for English and American technologists if they will but take them.

In a short chapter devoted to the radio-active minerals, reference is made to the recent estimation of the atomic weight of the lead contained in them; if this element is the end-product of the thorium disintegration, the *isotope* of Soddy, its atomic weight should be slightly higher than that of ordinary lead; the value found in a recent determination is 208·4, a result surprisingly in accord with theory.

Part ii. deals with the chemistry of the elements, and this section, occupying some 130 pages, is perhaps the most valuable part of the book. It commences with a discussion of the properties of the elements of the yttrium and cerium groups, and of the methods for their separation; the greatest success appears to follow the method of fractional crystallisation, first successfully applied to didymium by Welsbach in 1885, when he succeeded in separating that supposed element into two bodies, having slightly differing atomic weights, naming them neo- and praseo-dymium; it will be remembered by some that the values published at the time by Welsbach were inverted, praseodymium being given at 143·6 and neodymium as 140·8, and it was not until 1898 that Brauner discovered and directed attention to the mistake.

The discussion of the spectrum examination is a little disappointing; the use of the spectroscope in the analysis of the rare earths is of immense importance; the absorption spectra can now be photographed from the extreme ultra-violet down to the least refrangible limit of the visible spectrum if a suitable source of light is combined with the panchromatic plates that are now on the market.

In dealing with emission spectra it is suggested that to observe spark spectra one pole of an induction coil is embedded in the oxide to be examined and a spark passed! This seems to be a very unusual procedure; in general practice the spark is either passed between platinum wires in a strong solution of the earth or else carbon rods saturated with the solution are used as electrodes; reference is made to the "reversion spectrum" discovered by the late Lecoq de Boisbaudran, but no details are given; as in some cases this method is of considerable value, it may be worth while to note that it is described in the *Comptes rendus* for 1886 (vol. cii., p. 153).

We must take exception to the rather summary dismissal of the kathode luminescence spectra discovered by Sir William Crookes some years ago; it is stated that the researches of De Boisbaudran, Baur and Mare, and Urbain have shown that these spectra were due to minute traces of a coloured earth in a large quantity of a colourless one, and that the sensitiveness of the method is so great that it cannot be employed for the ordinary purpose of chemical analysis; this may be partly true, but there is abundant evidence of the value of the kathode spectra when applied to the rare earths if the technique of the application is thoroughly understood. The sulphates of many of the earths give discontinuous spectra of great beauty and minute detail quite distinct from the nebulous luminosities produced by mixing coloured and uncoloured earths and submitting the mixture to the action of kathode rays; the oxides also, when in a state of purity and under certain conditions, give rise to a further novel series of characteristic phosphorescence spectra, and it is a matter of regret that this method of analysis has not received the attention that it deserves. We feel that the possibilities connected with it are too valuable to allow it to be lightly set aside as worthless.

For the general examination of the rare earths arc spectra are stated to be the most trustworthy, and a valuable feature is the inclusion of lists of the dominant lines in the spectrum of most of the elements.

The last section, the technology of the elements, is largely occupied with an account of the "mantle" industry; from a very interesting historical sketch it appears that the employment of the rare earths had been suggested for the production of light from very early times; mantles of platinum coated with lime and rare earths were used so far back as 1839, and mantles made from gauze that had been impregnated with lime and magnesia were used in 1849. The success that has followed the invention of Auer von Welsbach is due in great measure to the accidental discovery that the combination of about 1 per cent. ceria with thoria greatly increases the luminosity of the material, and this composition is now universal.

The commercial preparation of thorium from monazite is fully set out, and the various fibres used for forming the skeleton of oxide are described. Cotton has been replaced by ramie thread, and this in turn is giving way to artificial silk and similar materials, which on account of their uniformity are found to produce more robust and lasting skeletons.

In addition to the mantle industry there are already many other valuable technical applications of the rare elements, and some of the more important are given. Zirconium in particular has properties that render it valuable in many ways; the metal has a very high melting point, and is so hard that it can be used as an abrasive and for glass-cutting; the oxide is largely used in the manufacture of crucibles and furnace linings, and for many other purposes; it has even been suggested as a toilet powder. Among the properties of the metals of the cerium group is the power of forming pyrophoric alloys; cerium with 20 per cent. of iron is said to form an alloy which gives showers of sparks when scratched or struck, and "lighters" made from this and similar alloys are already in use.

The last chapter of the book is devoted to a discussion of the technical possibilities of titanium and its compounds; there are many uses suggested for this interesting element; its very high melting point, 2350° C., renders its employment in metallurgy difficult unless first alloyed with iron, as ferrotitanium; from this many valuable alloys have been formed.

But enough has been said to show that Mr. Levy's book is no ordinary text-book; it is original in its design, contains a vast amount of valuable information connected with the rare earths and the minerals in which they are found, and gives a very complete account of the present technical application of many of them; and it offers great encouragement for further research in this interesting and little-worked branch of inorganic chemistry.

James H. Gardiner.

ABNORMAL PSYCHOLOGY.

(1) *Psychopathology of Everyday Life.* By Prof. S. Freud. English Translation with Introduction by Dr. A. A. Brill. Pp. vii + 342. (London: T. Fisher Unwin, 1914.) Price 12*s.* 6*d.* net.

(2) *The Unconscious. The Fundamentals of Human Personality, Normal and Abnormal.* By Dr. M. Prince. Pp. xiv + 549. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

(1) THERE has been a rapid growth of interest, during recent years, in the theoretical explanation and practical treatment of mental diseases, especially of those so-called "borderland" cases between the normal and the definitely insane. The problems involved have aroused vigorous controversy, and the most conflicting views have been put forward by different schools of thought. Among the exponents of these various doctrines two of the most distinguished are Prof. Freud, of Vienna, and Prof. Morton Prince, of America.

Broadly stated, Freud's psychological system is based upon a fundamental distinction between two classes of memories and mental tendencies, viz., ordinary memories and tendencies and those that have for one reason or another been *repressed.* The latter are those involved in mental conflicts and accompanied by pain. They constitute the true "unconscious" of the mind. The other memories are classed by Freud as "pre-conscious." Unconscious memories and mental tendencies retain their original intensity, and although outside of consciousness continue to act, and from time to time affect consciousness. "Like the shades in the Odyssey," says Freud, "they come to life again as soon as they have drunk blood." When especially intense, or when the repressing power of the mind is in one way or another diminished, they may produce the symptoms of hysteria and of other forms of mental disease. But they are also the cause of dreams in normal persons, and of the apparently unintentional mistakes in speech, writing, and other actions, to which we are all more or less subject when our attention is distracted. Freud tries to sustain this latter view in his "Psychopathology of Everyday Life." He contends that the method of psychoanalysis,[1] or free association, demonstrates conclusively that such slips of memory, speech, and writing are really intentional, and due to the concomitant working of unconscious mental tendencies. In his view the problem for psychology is not why we are able to remember, but why we come to forget, and his own solution of the problem is that we forget the unpleasant, except when special factors make this forgetting impossible.

The theory is a comprehensive one, and not so easy to refute as might at first sight appear. There can be no doubt that in quite a number of cases repression plays an important part in the forgetting of unpleasant incidents, and that unconscious mental tendencies sometimes prove their existence by disturbing our speech and other acts. But the exceptions are numerous, and even some of the cases which Freud himself analyses at length seem to admit of other explanations. The book is extraordinarily interesting, however, and full of hints for the student of human nature.

(2) Dr. Prince's book is an excellent introductory text-book for medical psychologists. It sets out very clearly the various senses in which the word "unconscious" has been used by different writers, and shows how important the concept, when adequately defined, is for abnormal psychology. Morton Prince distinguishes what he calls the co-conscious from the unconscious.

[1] See "What is Psychoanalysis?" Nature, February 5, 1914.

The former is the split-off or dissociated consciousness demonstrable in cases of hysteria, etc., the latter is to be thought of best in physiological terms. He recognises the existence of repression, in the Freudian sense, in certain cases, but is unable to verify its universal existence in pathological cases. Many of the instances which he quotes are also strong evidence against Freud's view that sexual experiences, especially those dating from early childhood, are invariable factors in the production of neuroses.

Towards the end of the book there are some excellent chapters on instinct, emotion, and sentiment, which form an important contribution to the question of the nature of personality. The book will be found extremely helpful by those medical men who desire a well-balanced statement of the facts and theories of medical psychology at the present day.

WILLIAM BROWN.

PASTEUR AND PREVENTIVE MEDICINE.

(1) *Pasteur and after Pasteur.* By Stephen Paget. Pp. xii+152. (London: A. and C. Black, 1914.) Price 3s. 6d. net.

(2) *On Pharmaco-Therapy and Preventive Inoculation applied to Pneumonia in the African Native, with a discourse on the Logical Methods which ought to be Employed in the Evaluation of Therapeutic Agents.* By Sir A. E. Wright. Pp. xii+124. (London: Constable and Co., Ltd., 1914.) Price 4s. 6d. net.

(1) IN this volume, one of a series of manuals on medical history, Mr. Stephen Paget, with his usual facile pen, outlines the life of Pasteur. Commencing with his early years, we have a glimpse of Pasteur's home and of the ideals which influenced his whole life:—

"Work hard, honour your country; put spiritual things above material, and other people before yourself; have courage, have patience." . . . "Work; love one another," he writes to his little sisters. "Once you have got into the way of working, you cannot live without it. Besides, everything in this world depends on it."

An excellent description follows of his chemical researches, his study of tartaric acid and of the tartrates, and the foundation of stereochemistry therefrom. In January, 1849, Pasteur is offered and accepts the professorship of chemistry at Strasbourg:—

"Friendship met him on the threshold, and Love was waiting for him just across it. Friendship was young M. Bertin, who had been at school with him, and was now professor of physics in Strasbourg: Love was Marie Laurent, a daughter of the rector of the academy. . . . Within a month, he had sent to her father his formal proposal of marriage. At the end of May they were married. She was everything to him: without her, his work would never have been accomplished: he would have died, long before he did, under the strain of it. To write of him, is to be writing of her: the two lives are one, from 1849 to the day he died."

Pasteur's studies on fermentation and its influence on Lister's work are next discussed, and a beautiful little picture is given of Lister, the man:—

"In 1893, the death of Lady Lister took the delight out of his life. . . . To recall him, is to think, first, of the dignity, gentleness, and refinement of his face: its delicate colouring, the tranquil, almost dreaming, look of his eyes. . . . He smiled, not laughed: a smile of singular beauty, but hard to interpret. . . . Tired, lonely, and, long before he died, broken in health and in the enjoyment of living, one thinks of him, still as a man serene through controversy, a spirit of invincible patience and of radiant purity."

One of the traits of Lister's character, which the reviewer likes best to remember, was his intense concern for the welfare of the patients who came under his care—an untoward incident was a real grief to him.

Subsequent chapters deal with Pasteur's other researches—diseases of silkworms, anthrax, chicken-cholera, rouget—culminating in his work on rabies, soon after which he began to fail:—

"Then came enfeeblement, a year of quiet resignation; and, in September, 1895, his death. It is recorded of him that he died holding the crucifix in one hand, and in the other his wife's hand. Here was a life, within the limits of humanity, well-nigh perfect."

All that is mortal of the great master rests—most fittingly—in the beautiful little chapel in the Pasteur Institute, Paris.

Pasteur's work is fundamental and must be regarded as the starting-point of modern bacteriology and of experimental immunity and preventive medicine. Mr. Paget is able from a consideration of all that has since been accomplished in the prevention of diphtheria, plague, cholera, typhoid, and yellow fevers, malaria and Malta fever to show how much we owe to the genius of Pasteur.

We heartily congratulate Mr. Paget on his book, which is deeply interesting, and holds the attention from start to finish.

(2) Three topics are dealt with by Sir Almroth Wright in this book: first, the use of an organic copper compound "optochin" for the treatment of pneumonia; secondly, the nature of the pneumonia which attacks the native labourers in the Rand mines, and the employment of prophylactic inoculations to prevent it; and thirdly, a discussion of the logical methods which ought to be applied

in inquiries into the efficacy of therapeutic agents as applied in actual practice. The last-named would perhaps have been better published separately, and need not be further considered here.

As regards "optochin," it is found that this drug exerts a specific bactericidal action on the pneumococcus in high dilutions in serum as well as in watery solution. It has been successfully used as an application in local pneumococcic affections, and though some have been favourably impressed with it in the treatment of pneumonia, others have not found it to be of value. There is also some risk to eyesight in its use.

The pneumonia of the Rand was found to be a pneumococcal infection, and the native seems naturally to possess much less immunity towards the pneumococcus than does the white man. Various trials were made of pneumococcus vaccine as a preventive of pneumonia, and it is finally recommended that a dose of 1,000 millions of pneumococci cultivated in glucose blood broth might be appropriately employed as an ordinary prophylactic dose, as this was found considerably to reduce the incidence of pneumonia among those treated, as well as reducing the mortality if pneumonia occurred among them.

A very large amount of experimental work was carried out in this inquiry by Sir Almroth Wright and his collaborators, and the manner in which the results were controlled and are tabulated are models of what a scientific investigation should be, and form a valuable contribution towards the control of a disease which causes serious loss of life, as well as being one of considerable economic importance in the Rand. R. T. Hewlett.

ELECTRICAL ENGINEERING.

(1) *American Handbook for Electrical Engineers: a Reference Book for Practicing Engineers and Students of Engineering.* Compiled by a staff of specialists. Harold Pender, editor-in-chief. Pp. xviii + 2023. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 21s. net.

(2) *Electrical Engineering in India: a Practical Treatise for Civil, Mechanical, and Electrical Engineers.* By J. W. Meares. Pp. xxxvi + 517. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1914.) Price 15s.

(1) In its thousand pages this "American Handbook" contains information on an enormous variety of subjects arranged alphabetically from "Abbreviations" to "X-Rays." The work is a sort of combination of a library of text-books with a collection of formulæ and data. In the latter department, which must be regarded as its true field, the book will be found of great service to electrical engineers, but the utility of the text-book portion is, perhaps, open to doubt.

Each section appears to have been written by a man having a thorough and practical knowledge of the subject, and the theoretical and descriptive matter is excellent so far as it goes; where it bears directly on the tabulated matter it is also most useful. But the necessary limitations of space prevent it from being anything like a satisfactory substitute for the detailed text-book. We get just a very brief summary of the leading facts, but we are also given references to other books in which fuller information can be obtained.

Although we would not agree with everything contained in the book (for instance, we do not approve of "abohms," "abamperes," and so on, and do not even admit any necessity for the so-called "absolute" systems of units), we must say that the volume is a useful accessory to the electrical engineer's desk or library.

(2) This book contains a considerable amount of information on electrical matters with special reference to the conditions as to climate, cost, and legislation as they exist in India, but we have some difficulty in imagining a class of engineers to whom it will be really useful. The elementary matter is too scrappy, and too much jumbled up to be of service to a beginner, or even to one who has forgotten; to the man who knows already it would be sheer waste of time to read it.

There is much descriptive matter, but there are very few illustrations; without them the written matter is almost worthless. Most engineers will, we think, prefer a good standard text-book, of which there are a few, for getting up the elementary theory, and one of the well-known "pocket-books" for tabulated data.

David Robertson.

OUR BOOKSHELF.

English Folk-song and Dance. By F. Kidson and M. Neal. Pp. vii + 178. (Cambridge: At the University Press, 1915.) Price 3s. net.

It is only in recent years that with the active collection and study of European folk-lore the folk-song and folk-dance have begun to receive the attention which they deserve. The collecting of English folk-songs, begun by the Rev. J. Broadwood in 1843, has since that time been actively prosecuted by Miss L. Broadwood, W. Chappell, Dr. Barrett, and Mr. Baring Gould. In 1898 the Folk-song Society commenced its labours, and has year by year added to our knowledge of British and Irish folk-music. A summary of the progress already made and instructions to the collector were badly wanted. This has now been supplied in the present book, which deals satisfactorily with the problem of the origin of folk-music, and fully describes the methods of notation. The songs of the folk are classified under the heads of narrative ballads, love and mystic songs, pastorals, the songs of the poacher and the highwayman, the soldier and the sailor, the pressgang, hunting, sporting and labour songs, carols, singing games of children, the popular street ballad, and the broadside.

As for the folk-dance, much of the knowledge which we possess is due to the enthusiasm of Mr. Cecil Sharp, who has hunted down the veteran dancers, and taught them how to instruct the minor societies which have been started in almost every large centre. The authors deny that the Morris dance is connected with the Moors, and prefer without good reason a Celtic derivation which makes it to mean "noble." The suggestion that it may be in part due to the Salii or leaping priests of Rome is hazardous; there is more to be said for the theory which connects some of the figures with a primitive sun-worship. The sword-dance seems to be derived from some primitive rites of fertility. The manual is a good introduction to the subject, and the bibliography and illustrations leave little to be desired.

Masonry as Applied to Civil Engineering. By F. N. Taylor. Pp. xi+230. (London: Constable and Co., Ltd., 1915.) Price 6s. net.

The early part of this book contains descriptions of the various kinds of stones used in civil engineering, together with the methods of working and handling them. This portion cannot be described as altogether complete in itself; there are many references to another book by the same author. There is a certain off-hand manner in the treatment which has led to one, at least, unfortunate result. On p. 23 calculations appear giving the load which can be raised by a set of Weston's blocks when a given pulling force is applied. No allowance has been made for friction, hence the result of the calculation is altogether misleading.

In the later portions of the book the author deals with retaining walls, dock walls, dams, bridges, towers, monolithic and block concrete construction, shoring, and underpinning. It is probable that the reader will derive more benefit from the descriptions and drawings given in these portions than from the very brief theoretical discussions and calculations. On p. 43 there is an illustration showing a surcharged wall, together with a few lines of description supposed to indicate how to obtain the thickness of the wall. There appears to be some omission in the illustration; it is impossible to grasp the author's meaning. The treatment of the wedge method on p. 45 is imperfect, and again there appears to be omissions in the illustration.

In general, the author gives formulæ without any explanation of how these are derived. We do not think, therefore, that the book is likely to meet the requirements of modern students, who, for the most part, desire to be perfectly clear regarding the derivation, limitations, and assumptions involved in any formula which they are called upon to use in design.

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 Nature of Gas Ions.

Our knowledge of the nature of gas ions is derived mainly from measurements of their mobility in an electric field. Experimental evidence has shown that as the pressure (p) is altered the mobility (k) of the ion alters generally in accordance with the law, pk=constant; when this law holds good it is safe to conclude that the ion remains unaltered at the different pressures. One of the most interesting results of experiment is that in the case of the negative ion formed in air the product pk increases as the pressure is diminished below about 10 cm.; this result indicates a simplification in the nature of the negative ion at the lower pressures. Prof. Townsend and his students have examined this phenomenon in great detail, and have come to the conclusion that the velocity (v) of the ion should be expressed as a function of the field (X) and the pressure (p) in the form $v=f(X/p)$, indicating that the nature of the ion depends on the field and the pressure. In his recently published treatise Prof. Townsend concludes that the negative ion in a dry gas is in general a cluster of molecules which for a certain range of electric forces and pressures passes through a transition stage until finally, when X/p exceeds a certain value, the negative carriers are practically all electrons.

In some experiments recently undertaken to determine the mobilities of the ions formed by the radiation from polonium in thoroughly dried air, I have been led to conclusions essentially different from those now generally held. From a pressure of one atmosphere down to about 8 cm. the results were normal; at pressures below 8 cm. the negative carriers were found to consist of two kinds, electrons and ions, the former increasing in number relatively to the latter with diminishing pressure. In no instance was there any evidence of an intermediate or transition stage, the separation between the faster and the more slowly moving carriers remaining throughout clear and distinct. I was able to measure the velocity of the negative *ion* at all stages until resolution between the two kinds of carriers was no longer practicable, and it was ascertained that the value of pk remained constant from one atmosphere down to the lowest pressure employed (1/7 mm.), indicating that the negative ion remains unaltered in nature over this wide range of pressures.

The fact that electrons exist in dry air at the lower pressures is, of course, well known, but at a pressure of 12 mm. the ions constitute at least 80 per cent. of the negative carriers and at 1/7 mm. more than 50 per cent. The proportion of ions and electrons depends solely upon the pressure, the effect of the field being for the most part small or negligible. For the negative ion at all pressures v was found to be directly proportional to X/p; there seems to be no necessity for introducing any unknown function of X/p.

The fact that the electrons travel through several centimetres of a gas at pressures as high as 8 cm. without attaching themselves to neutral molecules is remarkable, and seems to imply that the distribution of carriers between ions and electrons must be determined immediately after the act of ionisation; it would appear that the electron has to be fired into the molecule above a critical velocity, otherwise attachment is no longer possible.

It was found that the positive ion remains unchanged in nature down to 1/20 mm., which was the lowest pressure tried.

An account of these experiments will appear shortly in the *American Journal of Science*.

E. M. Wellisch.

Yale University, Sloane Laboratory,
New Haven, Conn., April 6.

Migrations in the Sea.

The terms "anadromous" and "catadromous" are employed to distinguish fish which leave the sea to spawn in fresh water and fish which migrate from fresh water to the sea when they reach maturity. Gilson, in his paper, "L'Anguille" (1908, *Ann. d. l. Soc. roy. Zool. et Malacol. d. Belgique*, T. 43), proposed that the words should be used to define migrations to and from fresh water. The salmon, for example, is catadromous as a smolt, anadromous as a grilse, and so on. But unless new terms are to be created the words must be given a much wider significance than Gilson has suggested. The migrations of fish from the lower part of a river to the higher reaches, from a river to a stream, from the deep region of a lake to the shallows only differ in degree from the anadromous migration of the salmon. It cannot be said either that there is any difference requiring a new term in the migration of a fish from the sea into the lower part of a river or into an estuary. A fish which migrates from relatively deep water to the coast may also be said to have made an anadromous migration. There are species which may spawn in fresh or brackish water, and species which may spawn in salt or in brackish water. In short, it may be said that fishes present every degree of anadromous migration from mid-ocean to the upper limits of streams, and corresponding catadromous migrations. It is now proposed, therefore, that these words should be used to indicate the direction of the migration, however small or great that migration may be, whether passive or active, pelagic or demersal, seasonal or spawning.

But even with the wide meaning here suggested the words cannot be applied to an important feature of migrations in the sea—migrations brought about by current. The Gulf Stream is utilised by fish and other organisms for the conveyance of eggs and larvæ and young to, or towards, the continent, and its branches are no less importantly taken advantage of to convey the products from the spawning ground to a region which may be at some considerable distance. The drift may often be said to be an anadromous one, but it is sometimes catadromous, and frequently could not be defined by either term. The migration of the mature fish is in contrast to the drift of the larva.

This may be illustrated by reference to a species not a fish—the common edible crab, *Cancer pagurus*. The crabs on the east coast of Britain migrate, seasonally, catadromously from the coast for winter and anadromously to the shore region for summer. The mature females after ecdysis, sooner or later become ripe, and in response to the impulse thus conveyed migrate northwards along the coast. During or after this migration they become "berried." The larvæ, when liberated, are planktonic, and are carried by the current to the south. If there were, as there is some degree of evidence to show that there are, particular regions which present large associations of berried females, the young crabs would reach the bottom most numerously in areas to the south, which may be said to be related to the regions where the larvæ are liberated.

Thus with regard to this species there is a migration against the current of the mature females and a migration with the current of the larvæ, and these migrations are clearly quite distinct from the seasonal movements which characterise the species at the other periods of life.

The relationship of the spawning ground to the region where the demersal fry are deposited is better defined in the case of many of our species of flat fish and round fish, since it results in the formation of schools of seasonal migrants.

To define these and other migrations which are intimately associated with currents it is necessary, therefore, to introduce two terms which will serve to indicate movement against the current and with the current. My colleague, Prof. J. Wight Duff, recommends a Latin root, *natare*. The words suggested therefore are *contranatant*, swimming against the current, and *denatant*, swimming or drifting with the current. The words *contranatation* and *denatation* are also available to indicate the act or habit of migration against or with the current.

A. Meek.

Marine Laboratory, Cullercoats, Northumberland.

A Mistaken Butterfly.

In this connection the case should be recalled of the Cleopatra butterfly of southern France and Italy, the close relative of our English Brimstone. By waving a grass-green butterfly net in its vicinity I have frequently attracted the yellow and orange coloured males, which will flutter after the net and endeavour to settle on it. The female is similarly coloured to the female Brimstone, but is rather larger. A blue net fails to attract them.

G. H. Bryan.

THE "CRACKING" OF OILS AND ITS COMMERCIAL USE.

The great consumption of petrol as a motor fuel, which last year, in spite of the disturbing element of war, rose to the enormous volume of 120 million gallons in England, and to nearly ten times that amount in America, has led to the attempt being made to add to the natural supply by the so-called "cracking" of the heavy residual oils left after the petrol and the lamp oil have been distilled off from the crude oil.

The term "cracking" is one of those delightful Americanisms which express so exactly the meaning we wish to impart that it has been adopted universally—when a molecule is decomposed it is broken up: when it is merely resolved into simpler compounds it is "cracked." The term first came over with carburetted water gas, when the oils fed into the carburetting chamber were said to be "cracked," *i.e.*, converted into hydrocarbon gases of high illuminating value, but not "broken" into carbon and hydrogen.

A less violent form of the same operation can be utilised to convert the heavy hydrocarbon molecules in oil of high specific gravity and boiling point into volatile liquids fitted for use as a substitute for petrol. Most of the processes for doing this are based on a paper read by Sir Edward Thorpe and John Young before the Royal Society in 1871. This historical memoir was the first and only really scientific attempt to explain the actions that led to an increase in the yield of light hydrocarbons from a heavy oil under certain conditions of distillation, an action that had been first noticed in America in 1861, and was patented in England by James Young in 1865.

Thorpe and Young took $3\frac{1}{2}$ kilos. of paraffin wax obtained from shale and distilled it in an iron mercury bottle connected with a second by a bent tube carrying pressure gauge and stop-cock. The distillation was carried out over an open coal fire, one bottle containing the paraffin being heated, whilst the other acted as a condenser. In about four or five hours the distillation was completed, the pressure throughout being kept at 25 lb., and a magma of oil and unaltered paraffin resulted, which could be liquefied completely by the warmth of the hand. Four litres of liquid hydrocarbons were obtained, and on a preliminary factionation gave :—

Below 100° C.	0·3 litre
100–200° C.	1·0 „
200–300° C.	2·7 litres

Repeated distillations of the portion boiling below 100° C. resolved it almost entirely into three fractions :—

(1) 32°–38° C.,	consisting of	pentane and amylene
(2) 65°–70° C.,	„ „	hexane and hexylene
(3) 94°–97° C.,	„ „	heptane and heptylene

Members of the acetylene and benzene series were absent.

Extended experiments with the portions distilling from 100° C. up to 300° C., and the solid hydrocarbon left above 300° C., showed them to be mixtures of saturated hydrocarbons and olefines. In the fractions distilling below 100° C., these two classes of bodies were in nearly equal proportions, but above that temperature the proportion of paraffin hydrocarbon to olefine became gradually larger as the molecular weight increased.

In cracking a heavy oil there are two factors that govern the course of the actions taking place, and these are temperature and pressure. The first loosens the groups of atoms that build up the complex molecule; the second to a great extent determines whether the action is a dissociation or a decomposition.

The temperature at which the dissociation takes place is above the boiling point of the heavy hydrocarbons, and if no pressure is employed the oil vaporises and the amount of alteration that takes place is small and depends on the local heating of the vapours as they are formed, but if pressure is used the necessary temperature for dissociation is reached, and by suiting the temperature and pressure to the particular mixture of heavy hydrocarbons being dealt with, the maximum of alteration with the minimum of decomposition can be attained. Directly the action commences to be decomposition, gases are evolved, and carbon with heavy asphaltic bodies make their appearance in the residual liquid, while the volume of gas affords an index to the amount of decomposition taking place.

The more complex the original molecule the lower the temperature needed to loosen the bondage of the groups it contains, and therefore the easier to prevent decomposition; hence Thorpe and Young, using a nearly uniform compound like paraffin, were able to dissociate it entirely at a temperature of between 300° C. and 400° C., and prevent decomposition by distilling and condensing under a pressure of 25 lb., but when we come to deal with a mixture of complex molecules, such as are found in Solar oil, the dissociation temperature of some is well above the decomposition temperature of other molecules, and the temperature at which it is best to carry on the conversion can be found by determining the temperature at which part of the oil just commences to decompose, *i.e.*, gives off 10 or 12 cubic ft. of gas per gallon at atmospheric pressure, and then to regulate the pressure so as to prevent any gas being evolved.

With a Solar or other residual oil, what is wanted is a temperature round about 500° C., and a pressure that may run up to 1000 lb. or more if heavy oils are being treated. It is also clear that the heated hydrocarbons must be cooled down under pressure to prevent the chance of a decomposition temperature existing in the liquid and to prevent the escape of the more volatile products of the conversion as vapours.

It was this principle that was embodied in the apparatus which was patented by Sir Boverton Redwood and Sir James Dewar in 1889, and has been copied in the Burton process by which, at the present time, thousands of tons of heavy residual oils are being converted into lighter products by the Standard Oil Company. In both cases the form of apparatus is identical; large vessels or boilers are employed, and the pressure is restricted to 4 or 5 atmospheres, whilst the temperature is 400° C. to 500° C.

Burton's patent was granted on the grounds that by his process only hydrocarbons of the paraffin series were formed, whilst in all previous processes a mixture of the saturated and unsaturated series was produced, this idea being due to the fact that the bulk of the unsaturated hydrocarbons formed were naphthenes.

The inventor of another process obtains greater safety by heating the flowing oil in a coil of iron tube heated to about the same temperature (450° C.) in a bath of molten lead at a pressure of 40 to 50 atmospheres, the oil then flowing to a second coil in a water condenser; this process differs from the previous ones by the pressure being kept sufficiently high to prevent any vaporisation. These processes may be taken to represent simple conversion, and the products found in the low boiling portions are chiefly paraffins, olefines, and naphthenes.

A very interesting process for making "cracked" spirit is that devised by Mr. W. A. Hall, in which dissociation, decomposition, and recombination all play a part, as after vaporising the oil and passing the oil vapour at a rapid rate of flow through a great length of tube heated to about 600° C. under a pressure of 60 lb., he suddenly lowers the pressure by allowing the heated and decomposing oil vapours to pass into a 12-in. column and then through dephlegmators, which cut out the heavier portions of the residue, the vapours and gases passing on into a condensing chamber, where they are compressed to 100 lb., and under this pressure go through the condensing coils. There seems to be an endothermic reaction taking place during the condensation by pressure, as a fall of temperature takes place where one would have expected a rise from the compression, and the liquid finally condensed contains not only gas in solution, but excessively volatile hydrocarbons evidently formed by the nascent gases attaching themselves to other molecules or polymerising. Such a spirit is far more complex than one formed by dissociation acting alone, as, besides the paraffins, olefines, and naphthenes, we also find aromatic hydrocarbons, acetylenes, and bodies like hemiterpene and terpenes.

During the past ten years several processes have been introduced in which steam or water has been introduced with the oil into the cracking ducts, the idea being that hydrogen from the water would affix itself to the heavy hydrocarbons and hydrogenate them into lighter hydrocarbons; to aid this action catalysts have been frequently used, nickel being the most popular.

The idea of the use of nickel as a catalyst is twenty-seven years old, as, in 1888, Ludwig Mond took an English patent, 12,608 of that year, in which he mentions the treatment of hydrocarbons, together with steam, by passing them through heated vessels containing fire-brick or iron oxide, and he states that if metallic nickel is used in place of the iron oxide, then only a moderate temperature is required.

About 1900, Sabatier and Senderens studied the action of nickel and other metallic catalysts on the hydrogenation of oils, and in the following years there were many more patents taken covering its use. Still later there were a large number of patents taken in America by Dr. Day, Ellis, Kayser, and others, dealing with the use of nickel as a catalyst.

Mond, Sabatier, and Senderens all recognised that such surface action as the nickel exercised took place only at temperatures below, at any rate, 300° C., but the more recent exploiters of the idea have drifted back to the temperatures one would use for cracking, not for hydrogenation.

Mr. Edgar A. Ashcroft has been doing some extremely interesting and highly suggestive work. Starting with the theory that the crude oil, as we obtain it from the well, represents a mixture in which the groups of atoms forming the molecule have, under the influence of temperature and pressure existing during the formation of the oil, arranged themselves as compounds in a proportion that has given a natural equilibrium, he suggests that if the crude oil be distilled so as to eliminate the lighter fractions and the residue be again subjected to the same temperature and pressure as that at which it was formed, a natural equilibrium will again be reached by the formation of a mixture akin to the original crude oil, from which more light fractions can be distilled. In the same way, when coal is destructively distilled, the gas and tar represent a molecular arrangement which is in a state of natural equilibrium, so that by taking a middle fraction of the distillation of such tar, say creosote oil, and subjecting it to heat and pressure, tar, with its low boiling hydrocarbons, middle fractions, and pitch, should be again formed. That this is so is seen from the following experiment.

Two hundred c.c. of creosote oil, distilling between 240° C. and 350° C., were heated in an autoclave up to 490° C., which gave a pressure of 100 atmospheres; on allowing to cool down 180 c.c. of tar and 5 litres of very rich gas were found to have been formed. The tar on distillation gave:—

	c.c.	
First runnings, up to 170° C. ...	10	Benzol, toluol, and solvent naphtha
Carbolic oils, 170°–240° C. ...	20	Phenols, naphthalene, and anthracene
Creosote oils, 240°–270° C. ...	20	
Anthracene oils, 270°–350° C. ...	20	
Pitch (very fine)	30	

representing an ideal benzenoid tar.

The extreme suggestiveness of this work, both from the theoretical and commercial point of view, will be at once apparent as offering a method by which the least valuable fractions of tar and crude oil can be converted into those for which there is a greater demand.

SERVI SERVORUM DEI.

IT is not only His Holiness the Pope who is *servant of God's servants*; the title well becomes all who are saving or safeguarding the health of the British Expeditionary Force. To read the medical and surgical history of past wars—the American Civil War, or the Crimea, or the Franco-German War—is more pain than pleasure. To read what our Army Medical Service is doing now—a Committee has just been appointed for the writing of this history—will be not the least of the pleasures of peace. We have a foretaste of it, in the article which was published in the daily papers last week, by "an Eye-Witness present with general headquarters." He says, to begin with, that a war such as this, with so much hardship and exposure, would have cost our nation, a few years ago, an outbreak of disease that would have decimated our forces. He goes on to say that the low sick-rate in the Army to-day is due, partly, to the diligent instruction given of late years to our men in the first principles of health. "In the main, however, it is due to the preventive measures adopted by the medical service." And these preventive measures are of two kinds: those which prevent infection from gaining access to our men, and those which strengthen our men to withstand infection.

The article is mostly concerned, and no wonder, with typhoid fever. Yet, if we think of single cases, not of masses of cases, the protective treatment against tetanus, surely, is not a less achievement than the protective treatment against typhoid. Early in the war, the bad news came of many cases of tetanus; the heavily manured soil of France was full of tetanus; the very earth that our men were helping to defend was their enemy. It is a great blessing that a wounded man may indeed be safeguarded, with a dose of anti-tetanic serum, against this disease; and a great blessing that our men now are on soil which is fairly free from it.

But typhoid, after all, is the supreme test of the efficiency of an army medical service. We have learned of late years that the infection may be conveyed by flies, and by clouds of dust; we have learned also the danger of infection from mild, unsuspected cases, and from typhoid-carriers; we have left off thinking that typhoid cannot be spread without the help of a "polluted water supply." The present control of typhoid for our Army in France has been won by the bacteriologists; all honour to them:—

Mobile bacteriological laboratories have been installed expressly for this purpose (the early detection of cases). Each laboratory consists of a motor-lorry fitted with a complete bacteriological equipment, and is in charge of a specially-trained officer, and an attendant of the Royal Army Medical Corps.

Moreover, it is the bacteriologists who discovered the protective treatment against the disease. On March 5 we learned what our Army owes to that treatment. Of fifty deaths from typhoid fever among our men on active service, forty-eight had occurred among the non-protected, one in a man protected, and one in a man partly protected. Nobody in his proper senses can doubt that Nature finds it easier to kill the non-protected than to kill the protected.

It must not be forgotten that by far the most potent weapon in our armoury against typhoid fever has been forged by pathologists, before the war. Inoculation is the surest defence: and to its extensive use must chiefly be attributed the low incidence of this terrible disease in the British Army.

But the whole article ought to be read carefully, not in fragments.

Doubtless, when the hot weather comes, the work of safeguarding the Army's health will be no less arduous than it is now. For the present, let us be thankful for the splendid services rendered by men of science to our defenders, through all the bitter hardship and perils of the past nine months.

Stephen Paget.

THE USE OF ASPHYXIANTS IN WARFARE.

The use of asphyxiating gases by the Germans in forcing back the French lines to the north of Ypres has given rise to much conjecture as to the nature of the gases employed, and in a long article in a Sunday paper it is surmised that the gas used was carbon monoxide. The only foundation that can exist for such an opinion is that carbon monoxide is one of the most virulent gaseous poisons known, and that less than 1 per cent. in air rapidly proves fatal, but inasmuch as all the explosives in general use produce it in large quantities, the smokeless powders in use by England, France, and Germany, giving approximately 50 per cent. of the permanent gases formed as carbon monoxide, it is hard to believe that the enormous volume produced by firing the charge in the gun should have no deleterious effect on those using it, whilst the much smaller quantity given on the bursting of the shell should asphyxiate the enemy. The fact is, that carbon monoxide is slightly lighter than air, and when driven out by the explosion in a heated condition diffuses upwards so rapidly that scarcely a trace can be found at the breathing level, but when evolved underground in a confined space many accidents have been caused by its poisonous properties.

Moreover, carbon monoxide is in no sense of the word an asphyxiant, and one of its greatest dangers lies in the fact that air containing a poisonous amount can be readily breathed.

Later reports received on Monday and Tuesday make it evident that it was a true asphyxiant, such as sulphur dioxide, chlorine, or a mixture of the two that was employed, and that the fumes generated in front of the German trenches were borne down by a northerly wind upon the Allies. Some descriptions speak of the burning of some substance which gave a yellowish smoke and gases; others that the gases were contained in steel cylinders, the gases being conducted by hose-pipes some little distance in front of the trenches, whilst the men manipulating the cylinders wore divers' helmets, and the first German troops to charge over the gassed area wore smoke helmets or respirators. It is further probable that some shells containing a liquid giving gases of an asphyxiating character were also employed.

It seems to be clear from various descriptions that the gases floated close to the ground for a considerable distance, producing an effect of asphyxiation, which was felt as far as the Allies' second lines.

Both sulphur dioxide and chlorine would have produced the effects described, and the cylinders spoken of might have contained these gases in a liquefied form, whilst it is probable that shells used for asphyxiating purposes would be charged with chloride of sulphur which would itself decompose in moist air or in contact with water into sulphur dioxide, hydrochloric acid, and sulphur, or, if fired by the bursting of the shell, would give sulphur dioxide and chlorine.

Both sulphur dioxide and chlorine satisfy the requirements of being more than double the weight of air, and so might remain near the ground, diffusion being only slow, but it is difficult to understand how sufficient quantities of either gas were produced to render the air irrespirable at the distance of the Allies' lines from the German trenches.

RICHARD LYDEKKER, F.R.S.

Both zoologists and geologists lament the death on April 16 of Mr. Richard Lydekker, who had been for more than thirty years one of the most active workers in the natural history sciences. Born in 1849, of Dutch descent, he was educated at Cambridge, where he graduated in 1871, and was placed second in the first class of the Natural Science Tripos. Joining the Geological Survey of India in 1874, he began his scientific career in the mountains of Kashmir, of which he made a successful pioneer geological exploration. While there his opportunities for sport continued to foster his interest in zoology, and he soon acquired a good knowledge of the mammals and birds of the country. The great collection of Tertiary mammalian remains in the Indian Museum at Calcutta then attracted his attention, and he began a systematic study of these fossils, which he described in the *Palaeontologia Indica*.

With little material for comparison in India, and needing the corresponding collections in the British Museum for reference, Mr. Lydekker soon recognised the necessity of returning to London if his work was to be exhaustive. He accordingly retired from the Indian Survey in 1882, had the fossils from Calcutta sent in instalments to London, and by 1887 had completed the fine series of volumes describing not only the Siwalik Vertebrata, but also the pre-Tertiary Vertebrata of India. At the same time, between 1885 and 1887, Mr. Lydekker prepared for the British Museum a catalogue of the fossil mammals in the department of geology (in five parts), which was followed by similar catalogues of the fossil reptiles and amphibians (four parts, 1888–90), and fossil birds (one part, 1891). Though presenting only a somewhat hasty and superficial view of the subject, these catalogues were at the time of real utility; and they are noteworthy as the first systematic attempt to correlate the European with the more recently discovered American fossils.

In 1893, and again in 1894, Mr. Lydekker visited the Argentine Republic and spent some months in studying the wonderful collection of fossil vertebrates in the La Plata Museum. His work was published in two handsomely illustrated volumes ("Anales del Museo de La Plata," tomos II., III.), and gave the first satisfactory account of several of the peculiar extinct vertebrates of South America. His descriptions of ancestral Cetacea from the Tertiary, and Dinosaurian remains from the Cretaceous, formations are especially valuable. The visits to South America led Mr. Lydekker to appreciate more thoroughly the need for considering the evidence of fossils when dealing with questions of geographical distribution, and in 1896 he published a "Geographical History of Mammals," which is in many respects his most original and important work.

While occupied with purely scientific research, Mr. Lydekker did not overlook the needs of ordinary students, amateurs, and sportsmen, and during his later years most of his numerous writings were adapted for their use. So long ago as 1889 he contributed the volume on vertebrates to the third edition of Nicholson's "Manual of Palæontology," and in 1891 he co-operated with Sir William Flower in "An Introduction to the Study of Mammals." Between 1893 and 1896 he also edited the "Royal Natural History," and wrote the section on vertebrata. Work of this kind was facilitated by his occupation at the British Museum in arranging the exhibited collections of mammals and reptiles in the department of zoology, where he was employed from 1896 until the time of his death. He not only arranged the collections in an admirable manner, but also prepared several valuable guide-books. His last work was a catalogue of Ungulate mammals in the British Museum, of which three parts were published, and the fourth, completing the Artiodactyla, was left by him nearly ready for issue.

Mr. Lydekker was elected a Fellow of the Royal Society in 1894, and was awarded the Lyell Medal by the Geological Society in 1902.

DR. W. J. SELL, F.R.S.

WILLIAM JAMES SELL, university lecturer and senior demonstrator in chemistry at the University of Cambridge, died at Cambridge after a long illness on March 7. He was born at Cambridge in 1847, and for more than fifty years was connected with the chemical laboratories there, and contributed in no small degree to their development and success. He was barely fifteen when, on the recommendation of the master of the elementary school which he attended, he was employed at the chemical laboratory of St. John's College, at that time the only one in the University open to undergraduates. Here he learnt elementary analysis and the use of apparatus, heard the professor's lectures, and saw his experiments. He made good use of his opportunities, and soon made himself an efficient assistant. In 1865, when the Jacksonian professor of natural philosophy removed his apparatus into a new building, the room vacated by him was united with that of the professor of chemistry, and a room built above them for a students' laboratory, the first step taken by the University, in its corporate capacity as distinct from the colleges, to provide experimental training for its students. Here Sell was appointed attendant, and had charge of the apparatus, and not only assisted the professor in the experiments at his lectures, which at that time embraced physics as well as chemistry proper, but was much in demand to help the students, whose notions of making experiments were often crude. The laboratory was a poor place at best in comparison with modern laboratories, but it grew and became filled with students, to which result Sell's help contributed not a little.

In 1870 Sell married, and soon after entered Christ's College and matriculated in the University. He had acquired a good knowledge of chemistry, and of some other branches of natural science, and knew a little of modern languages, but no degree could be obtained at Cambridge without some acquaintance with Latin and Greek, and he had not learnt either. It was a formidable task to begin now, but he faced it with his usual quiet determination, studying Latin and Greek at all times when his duties at the laboratory permitted, passed the examination in both languages, and was then able to take the Natural Sciences Tripos for his B.A. degree. In this he obtained a first class in honours for chemistry in 1876. This success brought him private pupils, and therewith an increased income, very necessary for him because University posts were all meagrely paid; at the same time he took a demonstratorship instead of remaining assistant to the professor. A short time afterwards he succeeded to the place of principal demonstrator.

Although Sell's position in the University, thenceforward to the end of his life, was that of a demonstrator, it must not be supposed that his public teaching was confined to what is usually known as demonstrating, which is mainly done by the junior members of the staff. On the contrary, inasmuch as chemical science was constantly expanding and learners increasing in number, the lectures had to be more specialised and the classes subdivided. The University had not the means to multiply the professors, and so the staff of the laboratory had to meet the demand for more instruction as best they could amongst themselves. In this Sell was most serviceable. He shirked nothing so that the teaching might, so far as lay in his power, keep pace with the growth of knowledge, and for many years was in reality an effective professor, though in name only demonstrator. He was never what is called a brilliant lecturer, but was a sound teacher, who gained the confidence of his hearers, and attracted them by his painstaking sincerity and willingness to help anyone in difficulty.

Sell had been elected a Fellow of the Royal Society of London in 1900, and took the degree of Sc.D. at Cambridge in 1906. An attempt was made to get him promoted to the rank of reader in chemistry. The University has full power to do that, and there were similar applications in connection with other branches of learning, and Sell's friends thought that his distinction as a chemist, and his long and faithful devotion to the service of the University, gave him a claim to promotion at that time before any other aspirant to the same rank. The appointment of readers, however, does not rest with the University at large, but with a board composed of representatives of the various departments of knowledge, literary as well as scientific—in fact, with a body of specialists chosen as such. As always happens in such cases, every member of the board thinks that his foremost duty is to see that his own particular subject of study gets its share of money and places, and magnifies it accordingly, so that the board scarcely ever pulls together for the general advantage, still less to do justice to an individual. No readership was created at that time, and all the recognition Sell got was his appointment to a University lectureship with a stipend of 50*l.* a year.

In his younger days, when it was as much as he could do to maintain his family, he could scarcely spare time for original investigations; but later, when the laboratory was grown up and needed less nursing, he was able to show that he had the capacity for successful research and the will to advance knowledge himself, quite as much as to put others in the way of doing it. He will be best known by his work on pyridine derivatives, to which he was led by previous studies of citrazinic acid. These were the subjects of a large number of communications to the Chemical Society from 1892 onwards. In some of these researches he was assisted by one or other of the advanced students in the laboratory, while in other cases he worked alone. Without going into details, it may be mentioned that from pyridine he obtained eight distinct chloro-derivatives, and from pyridine hydrochloride, in addition, some remarkable dipyridyl compounds. Moreover, he did not fail to demonstrate the chemical constitution of most of the new compounds he discovered. Other subjects of interest investigated by him were the salts of a base containing chromium and urea, and colloid solutions of phosphates. All he did bore the stamp of careful accuracy, and he impressed on his pupils the necessity for sparing no pains to ensure this, if any real advance of knowledge were to be made.

He was so unassuming that only those who had known him long found how much was hidden under that modest behaviour. It really meant that he wished always to do what was right, whether convenient or inconvenient, and to believe other people to be as good as himself.

NOTES.

Dr. H. Kamerlingh Onnes, professor of experimental physics in the University of Leyden, has been awarded the Franklin medal of the Franklin Institute of Philadelphia.

In spite of the war, the usual Dutch biennial congress of Science and Medicine was held this year, at Amsterdam, the first day being April 8. In 1917 the congress will meet at the Hague.

Dr. J. Alexander Murray has been appointed general superintendent of the Imperial Cancer Research Fund, and director of the laboratories, in succession to Dr. E. F. Bashford.

The Meteorological Office announces that Mr. J. E. Cullum retires from the post of superintendent of the Valencia Observatory, Cahirciveen, Co. Kerry, Ireland, and that Mr. L. H. G. Dines has been appointed to succeed him, as from May 1. Mr. A. H. R. Goldie has been promoted senior professional assistant in succession to Mr. Dines at the observatory at Eskdalemuir.

At the beginning of the war the Meteorological Office ceased the issue of weather charts to the newspapers. Announcement is now made that from May 1 the weather forecasts from the Meteorological Office for the several districts of the British Isles will not be available for publication. The only forecasts issued will be in what is known as the harvest weather forecast service. These are entirely local in character, and are telegraphed to agriculturists upon payment of the cost of the telegrams.

The Civil Service Estimates for the year ending March 31, 1916, recently issued, contain various particulars with regard to the sums to be voted for carrying out the provisions of the National Insurance Act. The grant in aid of medical research, to be paid to the Medical Research Fund, is 56,500*l.*, which is the same as for the last financial year. The grant to pathological laboratories to assist in the provision of laboratory facilities with a view to the prevention, diagnosis, and treatment of disease is 25,000*l.*, which is only half that voted for the financial year 1914–15. The sums voted for sanatorium benefit and for the remuneration of panel practitioners remain the same as before.

For the meeting of the British Association to be held at Manchester on September 7–11, under the presidency of Prof. Arthur Schuster, Sec.R.S., the following sectional presidents have been appointed: Section A (Mathematics and Physics), Sir F. W. Dyson; B (Chemistry), Prof. H. B. Baker; C (Geology), Prof. Grenville Cole; D (Zoology), Prof. E. A. Minchin; E (Geography), Captain H. G. Lyons; F (Economics), Dr. W. R. Scott; G (Engineering), Dr. H. S. Hele-Shaw; H (Anthropology), Dr. C. G. Seligman; I (Physiology), Prof. W. M. Bayliss; K (Botany), Prof. W. H. Lang; L (Education), Mrs. Henry Sidgwick; M (Agriculture), Mr R. H. Rew. Evening discourses will be delivered by Mr. H. W. T. Wager on the behaviour of plants in response to light, and by Dr. R. A. Sampson, Astronomer Royal for Scotland.

A monument to the late Prof. J. H. van't Hoff was unveiled at Rotterdam on April 17. It consists of a bronze statue, double life-size, in sitting position, and has been placed in front of the school at which Prof. van't Hoff was educated. The monument is about 30 ft. high, and the statue itself is flanked by female figures representing "Imagination" and "Reason." On the front of the base is the following inscription:—

Van't Hoff,
1852–1911.
Physicam chemiae adiunxit.

The principal speaker at the ceremony was Prof. A. F. Holleman, of Amsterdam, who directed attention to the fact that owing to the war no foreign delegates were present, and that the proceedings in memory of an international investigator were entirely national in character.

It is announced that a committee, under the presidency of the Director-General, Army Medical Service, has been formed to provide the necessary co-ordinating authority for the compilation of an adequate medical history of the war. In connection with each of the chief subdivisions of the work, military and civilian members have been appointed, except in the case of the Section of Hygiene, in which both members are military. The constitution of the committee under the presidency of the Director-General is as follows:—*Medicine.*—Lieut.-Col. O. L. Robinson, R.A.M.C., and Sir William Osler, Bart. *Surgery.*—Lieut.-Col. E. M. Pilcher, D.S.O., R.A.M.C., and Col. F. F. Burghard. *Pathology and Bacteriology.*—Sir William Leishman, C.B., and Capt. F. W. Andrewes. *Statistics.*—Lieut.-Col. H. P. W. Barrow, R.A.M.C., Dr. John Brownlee, and Lieut.-Col. W. N. Barron, M.V.O., R.A.M.C. *Hygiene and Sanitation.*—Col. W. H. Horrocks, K.H.S., and Lieut.-Col. W. W. O. Beveridge, D.S.O., R.A.M.C. *Historical and Secretarial.*—Capt. F. S. Brereton, R.A.M.C., and Dr. W. M. Fletcher. In each section the members of the committee have been given authority to co-opt for the purposes of the section other persons, and it is hoped that in the various sections the best results of the varied experience now being gained will be selected and arranged for publication in the Medical History, and not left to be distributed in scattered communications published independently by individual observers.

The current issue of the *Quarterly Review* publishes a symposium on German "Kultur," and one of the four contributions is by Sir William Ramsay, K.C.B., who deals with the subject as illustrated by German science. He institutes an inquiry as to what share Germans have had in scientific discovery and invention and utilises the data found in "400 Jahre Pionier-Arbeit in den exacten Wissenschaften," by L. Darmstaedter and R. du Bois-Reymond, published in 1904. Between the years 1500 and 1600, out of a total of 176 names mentioned, 39 are German, or 22 per cent. Between 1600 and 1700, out of 312 entries, 48 are German, or 15 per cent. During the next century, the entries are 517, of which 72, or 14 per cent., refer to German discoveries. The period from 1800 to 1850 comprises 901 entries; of these Germans and Austrians form 234, or nearly 26 per cent. Between 1850 and 1900 the records comprise 1021 entries, of which 477, or 46 per cent., can be ascribed to Teutonic sources, but, as Sir William Ramsay points out, it should be remembered in connection with the large percentage of German names in the list that it was compiled by two German savants. The awards of the Nobel prizes are also summarised. "The awards of the Swedish Nobel Committee are unbiassed by any national spirit; four prizes of the approximate value of 8000*l.* are distributed annually, one for physics, one for chemistry, one for medicine, and one for literature. During the twelve years from 1901 to 1912 inclusive, 58 have been awarded, of which 17, or nearly 30 per cent., were received by Germans or Austrians." Similarly the ratio of German and Austrian foreign members and associates of the principal academies of the world is 28 per cent.

On April 20 Prof. H. E. Armstrong opened at Cardiff a conference on the extension of British trade, which had been arranged by the city's Technical Schools Committee and Development Committee. Prof. Armstrong, in his address, which is reported in the *Morning Post* of April 21, pointed out that there is at the present moment much fiery talk of capturing the enemy's trade, but that in view of its many defects an urgent need will be to develop and improve our own trade, and to preserve it from the attacks to which it will be subject, not only by our present foes, but by our Allies and the Americans. To ensure future progress, the general average of intelligence must be raised in the schools, receptivity and plasticity of mind, and some measure of alertness must be cultivated in the students. In addition to English and French, Spanish and Russian should be taught in place of Latin and Greek; for men will be needed to go out and discover exactly what is wanted in the countries which, after the war, will be opened to our trade. These men must be able to talk the language of the people whom they are seeking to make their clients. The proper use of coal is, in the future, one of the great problems which we have to face. No bituminous coal should be used directly as fuel; it should be first converted at least into soft coke, so that the ammonia and tar, which are ordinarily wasted, may be recovered and utilised. This is a duty we owe to ourselves and to posterity on economic grounds, as well as in the interests of agriculture and the internal-combustion industry in particular. Our future success as a nation will depend on the fruitfulness of our scientific research. The possession of enormous organisations such as they have in the great chemical works on the Rhine gives the Germans very great power. They do not hesitate to expend vast sums of money in research; they do not think in niggardly terms—as our Government has done within the past few weeks—of 10,000*l*. a year, but without hesitation spend 50,000*l*. a year on a single problem. Thanks to our schools and universities, not forgetting the Civil Service examiners, the ignorance of our commercial community on all matters scientific is lamentable in the extreme; whilst owing to a literary test only being applied, a specially unpractical type of mind has been selected during generations to administer our public affairs.

Although the wrought flints found in great numbers in Egypt have been discussed in various isolated papers, no detailed survey of them has as yet been accessible to students. This want is now being supplied by Prof. Petrie in the first part of an elaborate survey of the subject in *Ancient Egypt*, part ii., for 1915. Flint-working, he points out, began in archaic times, and gradually blossomed out into the grand style of the splendid forms characteristic of the Chellean and Achulean periods, which no later work has surpassed. The Mousterian and Aurignacian ages reflect the decadence of European man in the third glacial period. In this paper the Egyptian and European forms of implements are carefully and with abundant illustrations correlated. This survey, when complete, will be of great value to students of prehistoric antiquities.

Mr. W. Crooke contributes to part i., vol. xxvi., of *Folk-lore* a paper dealing with the Dasahra, an autumn festival of the Hindus. It is held on or about the autumnal solstice, and thus coincides with the harvesting of the autumn and the sowing of the spring crops. It is hence an important crisis in the life of the farmer, during which it is necessary to control, by means of magical rites, the evil spirits which are active at such seasons. It is also the time when after the close of the rainy season the roads become open, and in older times the warlike classes started on their annual raids. Hence it is regarded as an auspicious time for the commencement of any work of importance. A curious incident in the observances is the release of prisoners or their removal from the capital, lest by virtue of a sort of sympathetic magic the spiritual activities should be trammelled by their bonds or chains. It is thus in its original form a complex of animistic or pre-animistic usages, which have been worked over by Brahmans or courtiers, and have thus become associated with the later Hindu pantheon and with the ceremonial of native courts.

It has often been noticed that an interval of time, marked off by sounds, appears longer than an equal interval marked off by flashes of light. The illusion has commonly been attributed to the so-called visual after-sensation—the persistence of the effect of light upon the retina. A recent research, carried out in the psychological laboratory of the University of California, and reported in the *Psychological Review* for January, 1915, shows that when the intervals are very short (1 sec. or less) and the stimuli repeated, the rate in the sound-series actually appears quicker, as a rule, than the rate in the light-series, although the two rates are really the same. A sound-rate of 154 taps a minute appeared equal to a light-rate of 128 flashes a minute for one observer, and 134 to 150 flashes for others. The higher the rate and the longer the series, the more marked becomes the illusion. Those exhibit it most who depend either upon "general impression" or upon overt tapping with the hand.

The presidential address delivered by Prof. Tufts at the joint meeting of the American and Western Philosophical Associations had for its subject "The Ethics of States." The address is published in full in the *Philosophical Review* for March. The lover of paradox, says Prof. Tufts, can find no richer field than that of the ethics of States. "The State hales private persons before its bar if they violate person or property, break contracts, or enslave their fellows; but itself commits homicide and trespass, breaks treaties, and takes possession against their will of the persons and property of multitudes who have done no harm." The article analyses the historical and logical grounds for these paradoxes. Historically, States have been built by two great forces: lust for conquest and desire of gain. America has learnt the dangers implicit in corporations organised for profit when they are not themselves controlled. The evils of present international politics are due, not to too much, but to too little political organisation. Logically, the doctrine of the survival of the fittest should involve the conclusion that everything that exists is good—the victor is always the better, the king on the throne can never do wrong, the martyr on the cross has never been right. On the contrary, the article urges that competition between nations may be just as unfair and just as much in need of higher control as competition between individuals or companies in business. It concludes the present situation is bringing home to all nations the consequences of past political ideals in all their horror; and that the very appeals which both sides make for moral approval are indications of the emergence of a larger and higher international conscience.

The Ichthyological Laboratory of Astrakhan ascertained the existence of more than sixty representatives of the Caspian fauna in the branches of the lower Volga, some species of Mysidæ occurring at a distance of 180 miles from the sea. A dozen years ago also a number of Caspian forms were found near Saratof by the biological station at that town, and the same forms were found in 1911 by A. Derzhanin in the Volga below Kazan and in the lower Kama, one of which, *Metamysis strauchi*, occurs as far up as Yaroslavl. This is identical with the *M. volgensis* of Tretyakof, to which he assigned an Arctic origin. These Caspian forms Mr. Derzhanin believes to have been left behind on the regression of the Maeotis-Caspian sea (Proceedings of the Naturalists' Society of the University of Kazan, 1912–13).

The Journal of the Department of Agriculture and Technical Instruction for Ireland (No. 2) contains several papers of general interest. Mr. Falkner C. Mason describes a series of experiments which have been carried out during the past year in the veterinary hygiene division of the Department to ascertain how long an injection of tuberculin will confer upon a tuberculous animal the power of resistance to a second injection. This fact has occasionally been taken advantage of by unprincipled persons for fraudulent purposes. In the paper now referred to the trustworthiness of the test in such circumstances has been studied and methods are suggested to counteract any attempt to render the test abortive. The "Boom in Flax" is dealt with by Mr. A. L. Clark, who gives statistics of the extraordinary advance in the prices of this crop brought about by the war. All past records have been broken; not even during the American Civil War has flax realised so high a price as it is being sold at to-day. Mr. Hunter deals with the question of the improvement of the flax crop by propagation from selected plants, a field of work which apparently offers a very hopeful outlook.

The history of the plantation rubber industry of the east is given by Mr. T. Petch in the recently issued part of the Annals of the Royal Botanic Gardens, Peradeniya (No. vii. of vol. v.). The story affects Ceylon principally, where the records have on the whole been carefully kept. It is unfortunate that certain gaps in the early history are due to the lack of proper records during Thwaite's directorship. The successful introduction of Hevea is due to Wickham, and possibly also to Cross, through the agency of Kew; a few plants have probably also been derived from those collected by Collins near Para. Much diversity, both in leaf and bark characters, is noticeable among the trees of the plantations, but there appears to be no ground for supposing that the trees in the east differ essentially from those in Brazil from which fine hard Para rubber is obtained. The reports of Wickham and Cross are reprinted, and careful details are given of the distribution of the original trees in and from Ceylon. An account of the plantations in the east generally is also given, and is followed by chapters on tapping experiments, Brazilian methods, etc. The history of the introduction of Ceara and Castilloa in 1876 and of other rubber-yielding plants is also given.

The Geological Survey of Canada has published as Memoir No. 38, in three cloth-bound volumes, the report of the Chief Astronomer on the North American Cordillera, forty-ninth parallel. The author of this work, Prof. R. D. Daly, acted as geologist to the International Boundary Commission between 1901 and 1906, and the report, circulated in 1915, bears the date 1912 upon its title-pages. The recording of the field-observations in a highly mountainous region was hampered by the absence of large-scale and accurate maps; but coloured geological maps and sections are here published of the whole traverse across British Columbia, from long. 114° W. almost to the coast. Fossiliferous horizons are unfortunately scarce; but the igneous phenomena provided ample material for so keen a worker as Prof. Daly, and have led him to insert as chapter xxiv. an "introduction to the theory of igneous rocks." The possible origin of pre-Cambrian dolomites and limestones by chemical precipitation is discussed with similar breadth of view in chapter xxiii. During hard mountaineering work, the author's mind always sought for explanations, and this adds considerable brightness to his description of the structure of the Rocky Mountains, the Selkirks, and the Cascade Range. An overthrust of forty miles is suggested as one explanation of the grouping of strata in the Clarke Range.

Among recent Bulletins of the Commission Géologique de Finlande, H. Hausen issues (No. 31) a study of types of porphyry found in the glacial beds of south-west Finland, and points out that many of these are still of uncertain origin and cannot be used as guides in estimating directions of ice-movement. In No. 32, he utilises well-recognised types of erratics in tracing the spread of glaciers from Fennoscandia into Russia, and shows how the "Baltic ice," moving mainly from north to south, has locally obscured the traces of the earlier and greater glaciation of Russia by ice from the north-west. One of his maps shows interesting features of drumlins near Dorpat, and a lake at the south end of the Gulf of Riga, held up between the ice-front and an abandoned terminal moraine. W. W. Wilkman (No. 33) deals with the later shore-lines in eastern Finland, and indicates wave-like movements of the ground; while the director, J. J. Sederholm, in No. 37, emphasises the influence of fracture-lines in controlling existing features in Fennoscandia. He urges that fracturing and faulting may characterise the cover which conceals folded masses, and that this zone is commonly removed from considerable mountain-chains. Students of igneous contacts and metamorphism will find much to interest them in P. Eskola's detailed memoir (No. 40), written in English, on the Orijärvi region. The alterations undergone by limestones, siliceous "leptites," and basic igneous rocks consist almost uniformly in the introduction of iron and magnesium and the leaching out of lime and alkalies.

The Canadian Department of Mines continues the issue of its useful publications with the object of directing attention to the mineral wealth of the Dominion and of assisting all who may be inclined to take part in its development. A compact summary of the subject is to be found in a pamphlet of some eighty pages, "Economic Minerals and Mining Industries of Canada," which has been prepared especially in view of the Panama-Pacific Exposition of San Francisco. It contains indeed no particularly novel features, but brings the subject well up to date. Messrs. H. T. Kalmus and C. Harper have published the second portion of their researches upon cobalt and cobalt alloys, this part dealing more particularly with the physical properties of the metal cobalt. Elaborate tests have been made, and are recorded with much minuteness of detail; it might be suggested that the full plate illustration of the testing machine used in making the tensile tests is decidedly superfluous. An elaborate report is published by L. H. Cole upon gypsum in Canada. From the technical point of view this appears to give all the necessary information, but somewhat more attention might have been devoted to the geological problems involved; thus there is no mention of the accessory minerals, such as the native sulphur and the borates, the existence of which in some of the Nova Scotian gypsum deposits has long been known, and which shed a very interesting light upon the probable mode of origin of these deposits. The third part is also issued of the Report on the building and ornamental stones of Canada, this dealing with the province of Quebec. This report also is very rich in detail, and contains much valuable information; attention may be directed to the beautiful coloured plates illustrating the appearance of some of the more notable of the ornamental stones, which are admirably executed.

In the Tôhoku Mathematical Journal, vi., 2, 3, Mr. Kichiji Yanagihara, of Sendai, discusses the history of the Pythagorean equation connecting the sides of a right-angled triangle in Japanese mathematics. Methods of obtaining integral solutions of this equation were given by Matsunaga (eighteenth century), Ammei Aida (1747–1817), who gave a table of the first 292 primitive solutions, Shôzô Kikuma, Tanehide Chipa (1830), and Sôhei Kaneko (1845). The theorem of Pythagoras was in constant use in Japanese mathematics, and many wasanists gave their demonstrations in their works, but owing to the lack of systematic establishment of geometry many of their demonstrations are found to resemble that of Bhaskara's "Behold" method in his *Vîja Ganita*.

It is easily shown that the ordinary linear differential equation of the first order between two variables represents a family of curves such that the tangents at all points having the same abscissa pass through a fixed point on an associated curve S. This method was used by Czuber to obtain an approximate graphical solution of the equation by building up the curve out of consecutive small elements much after the fashion of the common construction for the logarithmic curve. In the Science Reports of Tôhoku Imperial University III., 6, Mr. Tetsuzô Kojima gives a method of obtaining a better approximation than that afforded by the original construction, and further employs graphic methods of a similar character to the approximate solution of certain other first-order equations, including the general equation of the first order and second degree.

The majority of recent researches on thermal radiation deal exclusively with stationary phenomena such as occur in a field when it has attained a state of constant temperature. In a note communicated to the *Atti dei Lincei*, xxiii, (2), 9, 10, Prof. T. Levi Civita has formulated a scheme applicable to the case of a variable field subject to given arbitrary initial and boundary conditions. The investigation is based on the assumption that energy of radiation is propagated with constant velocity, but that the specific intensity of radiation across any surface is not only a function of the temperature, but depends also on the direction of the surface. This hypothesis is necessary in order to account for the transference of heat from a hot to a cold region, Levi Civita represents this effect by the addition of a term in the expression for the intensity containing as a factor the temperature gradient along the direction of the normal. The analytical work leads to the deduction of an equation closely resembling that applicable to conduction of heat in a variable medium.

The April number of *Science Progress* contains an article by Mr. F. Hyndman in which the recent work of Prof. Kamerlingh Onnes and his pupils on the high electrical conductivity of metals at very low temperatures is summarised. In the case of mercury the conductivity at 2·5° absolute is 10^{10} times as large as at the freezing point of water, but Ohm's law no longer holds—the electromotive force required to drive the current increases a thousandfold for a 10 per cent. increase in the current. If the metal is tested in a magnetic field a small increase in the field may produce a similar large increase in the resistance. Dr. C. Davison, in another article, points out that increase of seismic disturbances along a geological fault may herald a serious earthquake and that attempts should now be made to foretell earthquakes in this way. In a further article Dr. J. Johnstone shows the uselessness of considering the organism as a thermodynamic mechanism, since it is continually arresting the increase of entropy which goes on in inorganic bodies. In an essay review of mathematical text-books the author directs attention to the need of mathematical books which will help men of science to use mathematics without having to wade through the present-day text-books, which seem only intended for the use of schoolboys and undergraduates.

Publication No. 9 of the Central Meteorological and Geophysical Institute of Chile consists of a discussion by Dr. Walter Knoche of the Hertzian waves recorded at San Carlos de Ancud in 1913. The wireless apparatus employed gives a continuous record from which the number of Hertzian waves, or atmospherics, can be enumerated. Assuming the apparatus equally sensitive throughout the whole period, and the nature of the atmospherics always the same, the daily and monthly totals show remarkable variability. July had more than 16,900 occurrences, the total for the year—allowing for failures to register—being about 40,000. One July day is credited with the enormous number of 8604. The winter months—the station is in 41° 52′ S. latitude—showed the largest numbers. No clear connection was established with barometric pressure, temperature, wind, humidity, or cloudiness. Rain fell on almost all the days of greatest frequency; but 107 days of the mid-winter months, May to August, were rainy days, so no inference could be drawn. In winter there seemed a distinct increase of atmospherics on days in which thunder was recorded, but in summer this was not the case. The data, however, as to distant thunderstorms do not seem to have been altogether adequate, owing to paucity of stations. A series of tables shows the number of atmospherics recorded for each hour of each day from April to December. For the first three months of the year only daily totals are given.

The damage done to telephone systems in the tropics by animal life was mentioned in the course of a paper and discussion published in the last number of the Journal of the Institution of Electrical Engineers. The culprits are of all sizes, from elephants and giraffes down to white ants and spiders. Mr. W. Ll. Preece described how the giraffes in East Africa, when their progress is impeded by a telephone line, have not the sense to draw back or "duck" their heads, but push on and carry the wires with them—and sometimes the poles too. The only wood which is respected by white ants is teak, and instrument cases should be made of this or of metal. A telephone instrument was shown which had been persistently used as a hive by a swarm of "bee-like insects," who entered by the slot for the switch-hook, and formed a comb inside which they re-formed as often as it was cleared away by the engineers. Instruments and also insulators have an attraction for spiders, and are often rendered *hors de combat* by their webs, but apparently they leave glass insulators alone, although much trouble is experienced in this connection with the ordinary porcelain type. The webs get coated with dew, and the insulation resistance is brought down to a few ohms only. Sir John Gavey said that the trouble was not always caused by the spiders building their webs in the insulators themselves, but that, in the Argentine these insects breed in millions in the pampas grass; as soon as they come to life they spin a single web, which the wind carries across the country, and veils of these webs sometimes collect from pole to pole and cover the whole of the wires. Cases of beetles boring holes in lead cable and laying their eggs in them have also been well authenticated, and Mr. J. E. Kingsbury had an instance of moths making their home in a multiple switchboard cable. Finally, owing to the troubles which not infrequently occur in bringing difficult local conditions into line with the requirements of home administration, one speaker said that the engineer in charge ran the risk of becoming a mere "red-tape worm" himself.

A long and important paper on the compressive and flexural properties of a series of Scottish building and road stones was presented by Mr. Robert Boyle to the Institution of Engineers and Shipbuilders in Scotland on March 23. Twenty varieties of stone, consisting of 211 specimens, were tested. The principal deductions from the tests on Scottish sandstones are as follows. The average ultimate compressive strength for specimens tested dry, at right angles to the bedding, was 479·4 tons per square foot. The average percentage difference in individual results for compression tests varied from 4·3 to 50·3, with a mean of the averages of 23·2 for sixteen varieties. The average percentage differences in individual results in bending tests were much less than in compression, whether dry or saturated. Plaster of Paris coating appeared to have no effect on the ultimate strength of the stone. The crushing strength, hardness, and specific gravity vary approximately as the lime and magnesia compounds, and the crushing strength and specific gravity as the percentage of iron oxides. The crushing and bending strengths vary directly as the specific gravity. The percentage ratio of absorption of water and the percentage porosity diminish as the specific gravity increases.

Engineering for April 23 gives an account of the Brooks Aqueduct, Alberta, Canada. This aqueduct forms part of the irrigation works of the eastern section; last year construction on this section was completed for the irrigation of 440,000 acres. The aqueduct is the first in which the hydrostatic catenary has been adopted for the shape of the water section; it has a length of 10,500 ft., and a capacity of 900 cu. ft. per second, and is the longest aqueduct yet constructed for carrying such a large quantity of water. The reason for adopting the hydrostatic catenary was that the total fall was limited to 4·85 ft. in 10,000 ft., and that consequently it was necessary to use this head to the very best advantage. The water section chosen is the most suitable, as it gives a maximum hydraulic radius for the given area, and a consequent low friction head. Structurally it is economical, for, when full, the shell is in simple tension and free from bending moments and shears. The idea of using this catenary for the water section is due to Mr. H. B. Muckleston, assistant-chief engineer, and it was adopted after experimenting with a full-sized model.

We regret that by an accident at the printing office after last week's Nature had been passed for press, the letter on "The 'Green Ray' at Sunset," appeared on p. 204 without the name of our correspondent, Mr. T. B. Blathwayt.

OUR ASTRONOMICAL COLUMN.

Comet 1915*a* (Mellish).—The following ephemeris of Mellish's comet (1915*a*) is published in *Astronomische Nachrichten*, No. 4796, and communicated by Dr. J. Fischer-Petersen:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
April 30	18 43 48	−10 44·6	7·1
May 2	46 54	11 56·8	
4	50 8	13 17·0	6·8
6	18 53 31	−14 46·2	

The comet is still situated in the southern portion of the constellation of Aquila, and lies towards the south-east of the stars 2 and 3 Aquilæ.

A note in the *Astronomische Nachrichten*, No. 4795, gives some further details about the discovery of this comet. In the Monthly Register of the Society for Practical Astronomy (vol. vii., No. 1, January and February, 1915), Mr. Mellish narrates how he first saw the comet on the morning of February 9. Daylight made it impossible to determine any motion of the object, and he had to wait until the following morning, February 10, before he was able to observe its slow movement, and thus recognise the object as a comet. Its position was R.A. 17h. 2m., and declination $+3^{\circ}$ $15'$. The comet is described as being $3'$ in size, bright, and having a very short, fan-shaped tail.

Astronomy and the War.—A correspondent of the *Morning Post* (April 23), writing from Paris on April 22, relates how astronomy is found among the victims of the war. At Nantes, he relates, "an electric tramway built out to an English camp put all the instruments in the observatory for the registration of terrestrial magnetism out of order, and made observation impossible. The observatory of the Puy de Dôme found itself cut off from the outside world at an altitude of 5000 ft. The funicular on which it depended in time of peace stopped working, and all the horses had been commandeered, so that the astronomers had the choice between leaving their post and being starved. Happily the problem was solved by the artillery depôt of Clermont-Ferrand, which undertook the task of provisioning the observatory."

Electric Furnace Spectra of Vanadium and Chromium.—The results of some very interesting experiments with regard to the variation with temperature of the electric furnace spectra of vanadium and chromium appear in the current number of the *Astrophysical Journal* (March, vol. xl., No. 2, p. 86), by Dr. A. S. King. The author has been able to record his observations at three separate temperatures, which he denotes as high, medium, and low. The temperatures on which the classification is based were recorded by a Wanner pyrometer, and were 2500–2600° C. for the high, 2300–2350° C. for the medium, and 2000–2150° C. for the low temperature. The metals used were metallic vanadium and crystalline chromium of "fair purity," and the furnace tubes used were of regraphitised Acheson graphite. The paper gives two tables of the intensities of the lines measured under the three temperatures, together with the arc intensities; several reproductions from the spectra are also included. The conclusions drawn indicate that the spectra of these substances develop similarly to those of iron and titanium, vanadium being very like titanium. The chromium spectrum near the temperature at which the vapour begins to radiate predominates in Class I. lines (lines relatively strong at low temperatures and strengthen slowly at higher temperatures), which change little at higher temperatures. Certain chromium lines, very diffuse in the arc in air, may be resolved into sharp components in a vacuum source, either furnace or arc. A large number of lines belonging to various furnace classes are relatively weak in this arc. The spectrum increases into the utra-violet as the temperature rises. The ability of lines to show self-reversal in the furnace distinctly increases with decreasing wave-length. The absence in the furnace of banded spectra which appear in the arcs of vanadium and chromium indicates that they are probably due to the oxides of the metals.

Recent Papers in the "Astronomische Nachrichten."—A large number of the issues of the *Astronomische Nachrichten* came to hand together last week, and while the material included is of too great and varied a nature to be dealt with in this column, it may help readers to know some of the chief contents. For this reason the following curtailed list of communications is given:—No. 4797: Observations of long-period variables (1914), by A. A. Nijland. No. 4796: Observations of the planet Jupiter, by H. E. Lau. No. 4795: Numerical investigations on a class of periodic orbits, by Carl Burran and Elis Strömgren; observations of comet 1913*f* (Delavan), by A. Abetti. No. 4793: The variable star W Cygni, by G. Hornig; Observations of SS = V 19 Cygni, by A. A. Nijland. No. 4792: Tables for the computation of precession for stars near the pole, by L. de Ball; ephemeris of the periodic comet of Tempel 2, Johannes Braae. No. 4791: Determination of the position of third order points on the moon's surface, by K. Graff and W. Voss; observations of the star BD 89·1°, with the large refractor of the Berlin Observatory, by L. Courvoisier. No. 4787: Observations and elements of the Algol star 10, 1914, R. S. Canum Venaticorum, by Cuno Hoffmeister; elements and ephemeris of the periodic comet of Winnecke for the appearance in 1915, by K. Hillebrand. No. 4786: Definite orbit of comet 1890 III., by S. Ogura and H. Kaneko; observations of Algol stars, by R. Lehnert; the orbit of comet 1913*f* (Delavan), by G. van Biesbroeck. The contents of the Nos. 4777 to 4785 will be given next week.

The "Gazette Astronomique."—In this column for December 24 last reference was made to the proposed publishing in this country of the *Gazette Astronomique*, the monthly bulletin of the Antwerp Astronomical Society, should sufficient financial aid be forthcoming. It is satisfactory to be able to record the appearance of the first number, but its continuance will depend on the support given to it in the future. The present issue contains an interesting account in English of the Uccle Observatory under German occupation, a description of a photograph of Delavan's comet, taken by M. G. van Biesbroeck in September last, a series of notes on astronomical current literature, etc. The first number promises well for future issues.

BRITISH GEOLOGY.

The series of memoirs published by the Geological Survey of Great Britain on the South Wales Coalfield reaches part xi. in the description of "The Country around Haverfordwest" (1914, price 3*s.* 6*d.*). Dr. Strahan is fortunate in having colleagues who, like himself, have become devoted to this particular ground. The district here described includes a considerable development of the Llandovery series, which is divided into local stages, the lowest of which rests, with an occasional conglomeratic facies (pp. 78 and 201), on rocks of Upper Bala age, while the highest stage laps over on to far older series. The Lower Old Red Sandstone is unconformable with the beds below it, and contains plant-remains, which are unfortunately indeterminable. The structure and economic features of the eastern part of the Pembrokeshire Coalfield are described.

The pre-Glacial wave-cut platform recognised in southern Ireland is shown to exist also at Milford Haven (p. 214). Dr. Strahan (p. 220) points out how the older glacial drift of the area was brought in from the north-west, and even from the west, by a lobe of the Irish Channel ice. Through a recent subsidence, the rock-floors of the valleys tributary to Milford Haven lie far below sea-level, and a submerged forest with flints worked by man, which were recognised by A. L. Leach, occurs at Amroth on Carmarthen Bay.

Memoir No. 83 of the Scottish series (1914, price 2*s.*) deals with "The Country round Beauly and Inverness." The names of J. Horne and B. N. Peach are still to be seen happily associated on its cover, with those of younger colleagues. One of the most striking features of the district is the Great Glen fault, which, despite its Caledonian trend, is later than some of the folding of the Old Red Sandstone, and has here a minimum throw of 6000 ft. The river-scenery is finely illustrated, and attention is directed (p. 82) to a deep pre-Glacial channel at the mouth of the valley of the Ness, the rock-floor of which has not been reached at 290 ft. below Ordnance datum. The Strathpeffer Spa, with its sulphur-bearing springs, is the main economic feature of the district. In a region so rich in human history, we wish that a geological survey might trench farther on the field of the geographer and the archæologist.

Drs. Peach and Horne have provided a description of the "Geological Model of the Assynt Mountains" (1914, price 1*d.*), which is exhibited in the Museum of Practical Geology, the Royal Scottish Museum, Edinburgh, and elsewhere. This modestly priced pamphlet, with its numerous sections, forms an excellent introduction for the student to the classic district of the Highland overthrusts.

The memoir to Sheets 110 and 116, entitled "The Geology of Caithness" (1914, price 4*s.*), is by C. B. Crampton and R. G. Carruthers. The maps (2*s.* 6*d.* each) with the memoir show a thinly populated country formed mainly by Old Red Sandstone, and descending from the Highland region northward, until it becomes, in comparison, a plain with "monadnocks," now stretching at about 150 ft. above the sea. Peat, as the useful system of shading shows us, covers a very large area. We miss a reference in the memoir to the old tale of the "Caithness grin," which was said to be developed among a hospitable folk by sighting a stranger across miles of level flagstone. The evidence for a Middle Old Red Sandstone Series, which was sustained by J. W. Evans in 1891, is fully substantiated in this memoir, in consequence of the studies made by Traquair on the fossil fishes. These include the interesting Palæospondylus at Achanarras. We should like to have a further account of the flora of the Caithness strata, beyond the brief references on pp. 5 and 81. The successive stages of deposition of the Old Red Sandstone in "Lake Orcadie" are well shown in diagrams on pp. 84 and 85. A downward warping of the Caledonian continental surface allowed of the accumulation, as Sir A. Geikie long ago estimated, of some 16,000 ft. of Caithness flags. The origin of red strata in a warm and fairly dry climate, where vegetation exists, but not in sufficient quantity to acidify the soil, is discussed in chapter ix. The considerable amount of calcium carbonate in the flagstones is attributed to an arid epoch, here called a cycle, affecting the deposits on the shores.

Thurso Flags (Upper Caithness Flags) cut by a typical ravine or "goe," south of Duncansby Head. Many of these "goes" are of pre-Glacial origin. Reproduced from the Memoir to Sheets 110 and 116, by permission of the Controller of H.M. Stationery Office.

The suggestion (p. 100) of the sudden suffocation of fish by the inflow of alluvium is supported by a recent observation of E. Kolb during his descent of the Arizona canyons. The gills of the fish were, however, in this recent case choked by mud during flooding of the stream, and not in a period of marginal recession.

The nearness of Cretaceous masses to the north-east coast of Scotland, and the possibility of the existence of outliers beneath the Glacial drift, is shown by the account (p. 131) of the Cretaceous sandstone of Leavad, which was recognised by D. Tait in 1906. This block, 240 yards in length, is used as a sand-quarry, and rests on a green clay which, from its foraminifera, G. W. Lee regards as perhaps of Pliocene age. This in turn rests on boulder-clay, so that, as happens in Ostpreussen (NATURE, vol. lxxxv., p. 470), local geology has been distinctly enriched by material imported during the Ice age.

The Geological Survey states that the issue of some of its colour-printed maps is delayed by work necessitated by the war; but it makes its own contribution to military needs in a pamphlet on "Sources of temporary water supply in the south of England and neighbouring parts of the Continent" (1914, price 2*d.*). The waters of sand-dunes, alluvium, and river-gravels are especially considered, and useful warnings are given as to pollution. It is remarked (p. 10) that a well sunk in sand or gravel on a chalk hill may lose its water if carried down to the surface of the porous chalk.

The proceedings of local societies, especially where universities are at hand to provide a stimulus, afford valuable supplements to the publications of the official surveys. The second part of vol. xv. of the Transactions of the Geological Society of Glasgow (price 7*s.* 6*d.*) forms an admirable example. All the papers record original observations in southern Scotland. Prof. J. W. Gregory (p. 174) treats of the red rocks of the Isle of Arran, which he regards as including Permian desert-beds at Brodick. These terrestrial deposits are, he urges, Lower Permian, and the appearance of conformity with the Keuper Marls above may be deceptive. G. W. Tyrrell (p. 188) describes critical sections in spots which he visited at Prof. Gregory's request, and is unable to discover any break in the sedimentation. The papers by P. Macnair, R. G. Carruthers, and J. E. Richey on the lower beds of the Carboniferous Limestone Series will do much to help workers in other districts, such as the north of Ireland. G. A. J. C.

EXPERIMENTAL BOTANY AT TRINITY COLLEGE, DUBLIN.

IN "Notes from the Botanical School of Trinity College, Dublin," No. 5, vol. ii., 1915, Prof. H. H. Dixon gives experimental proof that morbid changes spread through plants from branches killed by heat. If a portion of a branch be killed by heat and the substances dissolved as the result of the heating be washed away, morbid changes only take place after some fourteen days. In cases where no steps are taken to remove the poisonous substances liberated by the heating, the branches above the heated portion show morbid changes in the course of five days. It is clear from the experiments that with the killing of the cells by heat, substances are liberated into the sap which contaminate the water supply to the living tissues above, and that the morbid changes are not due to the cutting off of the supply of water.

In a further paper in the same number of the "Notes" Prof. Dixon gives the result of his investigations into the nature of the changes which are produced in the sap by the heating of the branches. Sap was extracted by means of a centrifuge from pieces of branches, and was examined both fresh and after steaming for the acidity, colour, presence of oxydases and quantity of dissolved substances. The steamed sap showed marked acidity, a much higher percentage of dissolved substance—indicated by the depression of the freezing point—and a development of colour, any oxydase present being, of course, destroyed. The presence of poisonous properties was proved by placing leaves of *Elodea canadensis* in the steamed and in fresh sap, when it was noticed that lethal effects were produced quickly by the steamed sap, and that the leaves would not recover when placed in water.

In a paper on the tensile strength of sap, Prof. Dixon records tensions of about 207 atmospheres and 132 atmospheres in a tube of sap collected from a branch of *Ilex aquifolium*. The former of these is probably the highest yet recorded for the cohesion of any liquid. The tensile strength of the sap of trees, like that of water, is considerable, but it is probably somewhat more stable under tension than pure water. Prof. Dixon and Miss Marshall have also examined the elements of the wood of trees in relation to the ascent of sap, and find no evidence to support Janse's hypothesis as to the intervention of the living cells in the ascent of sap in stems.

Mr. W. R. G. Atkins publishes a series of careful papers on oxydases and their inhibitors in plant tissues, and his work confirms that of Keeble, Armstrong, and Jones. The distribution of oxydases in the flowers of Iris has been particularly studied; when they are kept in darkness, the quantity of active peroxydases increases. In the Pogoniris group an active peroxydase is absent. The localisation of oxydases and catalases in some marine Algæ has also engaged the attention of the author.

ENGINEERING, EDUCATION, AND RESEARCH.[1]

RESEARCH.—Research for the solution of new problems is of great importance, but it is not a task for young and immature students. Many so-called researches, in which well-understood methods are applied to materials or subjects not themselves important, scarcely deserve the name. They amount to little more than class exercises. Most scientific societies receive papers in which a much over-elaborated description is given of known proceedings and precautions, in which the new results are of limited value without establishing any general law. But the value of real research, based on a clear formulation of a definite unsolved problem, cannot be overestimated.

Unfortunately, in engineering, the solution of unsolved but important problems is generally both difficult and expensive. Much, no doubt, is done by manufacturers who have a financial interest in the work. But their researches are, in general, not fully published. It is of great interest to the public at large and to other engineers that a scientific institution like this feels it part of its duty to advance knowledge by research, and is able to devote a fraction of its income for such researches as are beyond the means of private engineers. In most cases, a research committee of this institution begins by an investigation of what has been done before, and the summary of previous investigations which the institution publishes is not only a safeguard against mere repetition of experiment, but is valuable in itself. Prof. Martens, the director of the great State laboratory at Gross-lichterfelde, has said that in four cases out of five when a manufacturer brings him a problem, it is found that it has already been solved somewhere by somebody.

The War and Engineering.—We meet in circumstances not foreseen a year ago. A war of unprecedented magnitude, extending over a vast area, has broken on us with the suddenness and fury of a tropical storm. We are already proud of the courage

[1] From the presidential address delivered to the Institution of Mechanical Engineers on April 16 by Dr. W. Cawthorne Unwin, F.R.S.

and military skill of our Army, the magnificent work of the Navy, and the resource of the Government in meeting extraordinary emergencies. As engineers, we know that our dockyards, arsenals, and armament firms are great schools of technology where the utmost resources of science and experience have been utilised. Victory, if we reach it, as we confidently trust we shall, will largely be the result of the general progress in mechanical engineering and in the capacity of our factories and workshops, due to the concurrent exertions of all engineers, civilian and military.

In this war the question of transport for troops, for munitions, and for food has assumed an importance never experienced before. It is only by the use of every mechanical appliance that a war on the scale of the present one is possible. Conveyance of food, munitions, and troops beyond railheads to the nearest possible point to the firing line depends almost exclusively on motor traction. The vehicles comprise columns of motor-lorries, box-cars, motor-ambulances, motor-omnibuses for troops, motor-cars for officers, steam-tractors for guns and travelling kitchens. It has been necessary to provide large stores of spares and well-furnished repair shops.

I think we may regard the conveyance of the Expeditionary Force as a triumph of organisation. A committee of railway managers, formed before the war, had studied the necessary arrangements. Three hundred and fifty trains were at work, and they arrived at Southampton from all parts of the country, between dusk and dawn, at twelve-minute intervals, during ten days. The troops and their heavy equipment were detrained and embarked without a hitch, and, guarded by the Navy, were transported to Boulogne without molestation.

As engineers, we may recall with pride the words of Mr. Churchill in regard to the ships at the Falkland Islands battle and the cruiser raid. He pointed out that "all of a sudden the greatest trial was demanded of the engines, and they excelled all previous peace time efforts. Can you conceive," he said, "a more remarkable proof of the excellence of British machinery, of the glorious industry of the engine-room branch, or of the admirable system of repairs and refits by which the Grand Fleet is maintained without exhaustion?" In this connection I should like to refer to the reform effected by Lord Fisher, conferring military rank upon the old entry engineers of the Royal Navy. Hitherto, in spite of their invaluable service and the risks they ran, they were rated as civilians. Lord Fisher said that "the unapproached efficiency of the engineers in the Navy merited this tardy recognition of their all-important part in the splendid fighting condition of our whole Fleet."

If in this war the work of the mechanical engineer has assumed a new importance, if success depends on an enormous supply of munitions, if, as Mr. Lloyd George said, "the turning out of munitions of war not merely means success, but means the saving of lives," then a great responsibility is placed on the shoulders of engineers. They are called on for the utmost exertions and perhaps for more sacrifices than others, except those at the front.

Foreign Competition.—Nevertheless a retrospect of our methods and activities is not entirely favourable. *Fas est et ab hoste doceri,* and it is no condonation of the military crime of Germany to recognise that the enormously rapid industrial advance in that country has serious lessons for us. Consider these facts. In sixteen years the aggregate income of Prussia has nearly doubled. While our Mercantile Marine increased from 9 to 10 million tons, that of Germany increased from 1 to 2½ million tons. In 1870 Germany had seven shipyards employing 3000 hands; in 1900 she had thirty-nine shipyards employing 40,000 hands. Although Germany has on the whole poorer qualities of iron ore and coal, her production of pig-iron increased from 11 to 19 million tons annually, while ours increased only from 9 to 11 million tons. To-day her production of steel is nearly twice as great as ours.

Various artificial conditions have fostered German trade, some of which might, and others could not, be imitated with advantage. The German Government is poorer than ours, but it has much more clearly recognised the interdependence of science and industry, and the duty of the State to assist industry in matters beyond private initiative. It has spent very much more in providing the highest type of technical instruction and State research laboratories. The railways and canals being under State control, differential rates can be adopted to help traders. The banks, advised by a staff of scientific, legal, and commercial experts, have been ready to promote the trial of inventions, and to subsidise promising but necessarily speculative industrial undertakings on a scale unknown in this country. Amongst other influences which have adversely affected our manufacturers may be reckoned some perversities of the Patent Law. Hence it has come about that, since the war began, we find ourselves in want of important products we can no longer obtain, and we realise that Germany fights not only with her army, but with her science and industry.

The most striking examples of the plight to which we have been reduced are found in the chemical industries, which, however, involve a good deal of mechanical engineering. Aniline mauve was discovered in this country in 1856, but the Germans, and to a certain extent the Swiss, have practically captured the whole colour industry. Prof. Meldola stated that, in 1886, nine-tenths of the dyeing colours used in this country came from Germany. Yet these are essential to textile industries having an annual output of 200,000,000*l.*, employing 1,500,000 workers. The production of synthetic indigo in Germany has largely destroyed the cultivation of natural indigo in India. The value of imported indigo from India in 1895 was about 3,500,000*l.* At the present time it is about 70,000*l.* Baeyer discovered synthetic indigo in 1880, but nearly twenty years were employed in research and nearly a million pounds was spent before commercial synthetic indigo was placed on the market. That is immensely creditable to German faith in science. Before the war the world's demand for electrical porcelain was practically met by Germany alone. There are many other similar cases. In these industries Germany had no natural advantages, but only a greater scientific intelligence and greater confidence of financiers in supporting scientific advisers.

To take another instance of more interest to engineers. Germany has acquired a practical monopoly of the treatment of the complex ores of the baser metals. The whole of the ores of zinc, lead, and silver from the mines of Australia, the richest in the world, are under contract sent to Germany for reduction. The Australian Attorney-General stated that "German influence exercised a monopoly over the world's base metal industry, so complete that it excluded effective competition."

Happily, in the iron and steel industries we are in a better relative position. Metallurgists here and in Germany, Belgium, and the United States have learned much from each other, and we have no reason for dissatisfaction with our part in the progress made. We had a long lead, and the discoveries of Bessemer, Mushet, William Siemens, Thomas, and Gilchrist, and others kept us in the front rank. We have been outpaced in volume of production, but in the higher qualities of steel and steel alloys, both in investigation and the quality of our product, we still hold a lead.

The large demand for warships, guns, and projectiles has no doubt been a favourable factor. The establishment of laboratories directed by competent experts in steel works and the works of large consumers like the railway companies has tended to the improvement and standardisation of quality.

Nevertheless we do not maintain superiority in all departments. In the heavy steel and machinery trades we have a dominant position, but for lighter machines Germany, the United States, and Scandinavia have secured a large market. In the case of light and medium steel castings—those required for motor-cars, for instance—this country has become almost dependent on Germany and Switzerland. The use of steel castings has very greatly increased, and they add in an important way to engineering resources. So far as a reason can be found for the better and more uniform quality of Continental steel castings, it lies in the adoption abroad of the electrical furnace, and great attention to heat treatment. Many of the steel castings come from Switzerland, where the cost of raw materials must be greater than in this country, and the cost of carriage must balance the lower labour cost.

There is another point. After the war, when happier conditions return, our manufacturers must be willing to give designs, specifications, and estimates in metric measures for countries where the metric system is adopted. The use of the metric system is legalised, but its compulsory adoption is not likely to be enacted, at any rate for a considerable time, if indeed it is desirable, about which a good many of us have doubts. Meanwhile, in many branches the use of a double system of metric and English measures involves little difficulty. In fine machinery no doubt it is troublesome, but that at present must be faced.

Technical Education.—Samuel Butler said that life is the art of drawing sufficient conclusions from insufficient premises. It is certainly true of the engineer, not engaged in mere repetition work, that he has constantly to arrive at conclusions and to act on insufficient data. Probably no difficult engineering problem has ever in the strict sense been completely solved. The engineer has to make assumptions, to use approximate theories, to decide between material and negligible considerations, and to allow for unknown contingencies. Now, scientific training, if sufficiently advanced, does enable us to solve most problems which are clearly stated and data given, but its usefulness does not end there. The trained engineer with incomplete data reasons correctly, estimates probabilities, and knows the limit of the trustworthiness of his conclusions. He does not snatch at a pocket-book rule and ignore the assumptions on which it is founded.

Among the various causes which have contributed to German industrial development, a thorough and widely diffused technical education must be given an important place. The branches of industry in which Germany has acquired a dominant position are those in which advanced applications of science are most necessary.

In the highest branches of scientific discovery this country has held a very distinguished place. That has been largely due to men who pursued science without regard to any practical end, or even with a certain disrespect for the fruitful applications of science. The value of this pursuit of pure science is, of course, not to be underrated. Manufacturers, on the other hand, who are interested only in applications of science, have been a little contemptuous of scientific men who seemed indifferent to business. All that is no doubt gradually changing. The means of obtaining technical knowledge, and the desire to take advantage of it, have increased. But even yet we have no institutions quite equivalent in buildings, equipment, and staff to the great technical high schools on the Continent. In Germany and Austria, excluding chemists, there are four or five times as many students in technical high schools as in colleges of corresponding rank in Great Britain. America, Belgium, and Switzerland in this respect have closely followed Germany.

But now, putting aside political and moral considerations, it is the thorough and advanced character of the education in the technical high schools and the researches of their professors, to which indeed many of us are greatly indebted, which have so directly promoted German industry. It is sometimes said that the Germans only pick up other people's discoveries and apply them. I think that is untrue, or at least greatly exaggerated. As Dr. Ormandy has well said, "those who adapt scientific discoveries to industrial use are as entitled to honour and reward as those who made the original discovery." But there is another aspect of education in Germany which has a lesson for us—the German secondary school is far more efficient than ours. Lord Haldane said that "in this country we have never understood the significance of the secondary school. In Germany the whole educational fabric rested on it." Secondary education in Germany is State-supported and definitely graded. The Gymnasium, the Real-Gymnasium, and the Real-Schule are organised to meet the wants of boys intended for different careers. Further, the universities, the professions, and higher Government appointments (including those on railways) are practically closed to all who do not pass a severe State maturity examination after nine years' schooling. The precise arrangements differ in various States, but in each there is an organised system and great pressure on boys to reach a high standard. Also those who pass the maturity examination are excused one year's military service. The importance of that for us is that a great obstacle to really efficient technical instruction in this country is the inadequate preparation for it in the schools. Practically a year of the three years' college course must be given to work which could well be, and ought to be, acquired in school by lads of seventeen or eighteen. Perhaps the excessive attention to athletics has something to do with our intellectual shortcomings.

I have spoken of the value of an advanced type of technical education for engineers who aspire to positions of responsibility, but I do not overlook or underrate the necessity of practical experience. Both are necessary, but one should not be cut down at the expense of the other. There are many branches of engineering, and as to the relative importance of technical instruction, workshop, field, and office training, in different cases, there may be differences of opinion. Further, I am far from advocating the Germanisation of English education. Only it seems to me that some of our educational tools, like some of our workshop tools, are medieval and out of date, and that some of our faults need a remedy. If, as I suppose, the cost of the war must be paid out of the profits of industry, it is of importance that our efficiency should be increased. Sir George Reid has said that "captures of German trade in time of war will only be retained in time of peace by the capture also of the scientific methods of the Germans."

Testing Materials.—Half a century ago, most materials of construction were selected and bought on the reputation of the manufacturer. Experience roughly indicated the sources from which the most trustworthy supplies could be obtained. Now scarcely any material in large use is accepted without special testing in the interest of the purchaser. Such testing is primarily intended to distinguish suitable and unsuitable material and to protect the user from carelessness or fraud. But it has also acted as a stimulus to manufacturers to standardise and improve their products. Once it is known how good a quality can be produced, all manufacturers strive to reach it, and the average quality is raised. The rapid development of cement and of the higher qualities of steel has depended on the determination of their superiority by accurate tests in the properties required for special services.

With the introduction of mild steel, the quality of which ranges between wide limits, the need of systematic testing became urgent. Now there are testing laboratories in the works of most railway companies and in steel works. Also the practice of testing has been adopted in the case of many other materials. With the extension of testing has come the need of standardising tests themselves, a work now largely accomplished by the International Association and the British Standards Committee. But with the increasing stringency of specifications, perhaps more attention should be given to the calibration of the instruments used in testing. In physical investigations great attention is given to the determination of the errors of instruments and methods, and perhaps in material testing this has received too little attention. I do not suppose there are important errors in the indications of large testing machines, though a comparison of results in different laboratories would be interesting. Errors in subsidiary apparatus are probably more frequent. It is possible with a standard bar and a good extensometer, used by the same practised observer to measure the agreement or disagreement of different testing machines. I have found also the use of copper cylinders subjected to crushing to be a very convenient means of checking load indications of machines.

On the Continent and in the United States there are public laboratories, supported by the State, where anyone can have tests made, at moderate fixed rates, by a trained scientific staff and with great accuracy. Such institutions assist industry if, on one hand, they meet industrial requirements, and, on the other, are unbiassed by private interests. They have the advantage over private laboratories that they are under the direction of experts of exceptional experience and reputation, and are able to pursue investigation, continued often for long periods, beyond immediate requirements into fruitful by-paths. The view taken in Germany is that the work accomplished is partly of advantage to the manufacturer who calls for assistance, and so far should be paid for by him, and partly is of advantage to the nation in advancing science, which is the justification for a State subsidy. Hence it is incumbent on the public institution to publish results as freely as is possible without injuring private interests.

At Grosslichterfelde the annual income from fees for testing amounts to 20,000*l*., and the annual State subsidy is 12,000*l*. On the staff there are 230 persons, of whom seventy-five have had university training and thirty-eight technical high-school training. Since 1880 the work accomplished has steadily and regularly increased.

The Bureau of Standards at Washington is on a still larger scale, and does very similar work. It receives an annual subsidy from the Federal Government of 100,000*l*. The equipment is extraordinarily complete. For instance, it has a 600-ton testing machine at Washington, and a 1000-ton testing machine at Pittsburgh, both of the highest sensitiveness and accuracy. Such machines do not exist in this country. Happily, we have now a similar institution in the National Physical Laboratory at Teddington. Its functions are somewhat restricted by the characteristic English jealousy of State action, which I think is diminishing. It would be difficult to overestimate the service it has done in the solution of various mechanical, electrical, and physical problems which were unlikely to be attacked by private persons. Some of the researches started by this institution have been carried out there, and valuable papers contributed to our Proceedings. The superiority of English aeroplanes has been demonstrated, and their services for scouting and for directing artillery fire have been invaluable. When the Government required difficult experimental investigations to be carried out on aeroplanes, it found at Teddington a staff and an organisation already in existence and suited to the purpose.

It is a condition of commercial testing that the results should be available in a short time and at small expense. Hence ordinary tests are of a somewhat arbitrary character, and do not completely imitate the conditions of actual service. We test specimens of steel to destruction and measure ductility by plastic deformation, though in use the stresses do not exceed the elastic limit and the deformation is elastic. We test cement in tension and use it in compression. There is need for constant criticism of methods of testing and for the invention of new tests, such as tests for hardness and brittleness, although new tests must be cautiously introduced.

One small change could be easily made, and in some cases would be interesting. When a set of tests on a material has been made, the mean of the results is taken as the best value of the property measured. In physical investigations generally a further step is taken by calculating what is termed the "probable error," which broadly is a measure of the trustworthiness of the results. Calculation of the probable error is troublesome, but Martens has pointed out that the "mean error" is nearly as accurate, and good enough for practical purposes. The mean error is the sum of the deviations of the individual results from the mean, irrespective of sign, divided by the number of observations. The mean error is conveniently expressed as a percentage of the mean value. If the mean error is large, either the method of testing, the uniformity of the material, or the preparation of the test specimens is at fault. Generally the source of the error can be inferred. A large mean error in tests of steel would indicate want of uniform quality in the material, in cement—probably faults in preparing the test briquettes. Of two supplies of a material, that with the smallest mean error is preferable.

There is another kind of testing, likely in the future to be of increasing importance—that is, the measurement of strains in members of completed structures in order to determine the stresses to which they are actually subjected in service. Some years ago, after the loss of the *Viper*, measurements of the strains in the skin of a torpedo-boat slung in various ways were made at the request of the Admiralty. The object was to obtain information on the stresses in a structure supported on waves. Strain measurements on the members of bridges during the passage of trains have been made in Holland, in France, by Mr. La Touche and Mr. Sales in India, and by Prof. Turneaure in the United States. These observations throw light on two points—the trustworthiness of theoretical calculations of the stresses and the magnitude of the stresses due to dynamical actions which cannot be calculated. Recently Mr. I. E. Howard, engineer-physicist at the Bureau of Standards, has initiated a very extensive investigation which is to extend to large bridges, the Panama lock-gates, and steel-framed buildings. Some results on the stresses in the shell of a simple cylindrical tubular boiler have been published. A cylindrical boiler shell is a very simple structure, and the straining action is statical. It might be expected that theoretical calculations of the stresses would in that case be approximately verified by the observations. In fact it is not so. The distribution of stress is very much less uniform than it is assumed to be in theory and in the design of boilers. Of course, this is chiefly due to angle-irons and joints, which in most cases reduce the stresses, but, at any rate, greatly modify the stress distribution.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Glasgow.—The course of instruction in engineering for the B.Sc. degree is conducted upon the "sandwich" system. Under this plan, the laboratory staff is occupied during the six winter months in providing the prescribed lectures and demonstrations for the students. During the months April to October the ordinary students obtain their practical training as pupils in the various engineering works of the district. In summer the laboratories are accordingly employed only for special forms of instruction and for research. This year, at the close of the winter session, Prof. Cormack and his colleagues—lecturers, assistants, demonstrators, and mechanics—offered their services through the principal of the University to Lord Kitchener for any purpose connected with the production of munitions of war, which he might think fit to indicate. The Secretary of State, through the Master-General of the Ordnance, has cordially acknowledged the offer of the staff, and promises speedily to inform the University as to the manner in which it may be utilised to the best advantage. In the meantime, the Admiralty has, with the sanction of the University Court, made arrangements for using the equipment of the laboratories, and in particular of the testing machinery, for the purpose of testing the specimens of steel and other metals employed by the contracting firms who are manufacturing shells, etc. Prof. Cormack and Mr. Morley, lecturer on heat engines, have undertaken to supervise the operations under the direction of the Admiralty inspector. A large proportion of the engineering students, who completed their course at the graduation in April, have found places in the munition factories.

London.—Among the public lectures, which are open to the public without fee, to be delivered at University College, during the present term, are the following:—April 29: Prehistoric Egypt, Prof. W. Flinders Petrie; April 30: Serbian ideals, Miss Annie Christitch; May 3: The principles of technical evaporation and distillation, Dr. W. A. Caspari; May 4: Hindu religions, Prof. L. D. Barnett.

Oxford.—Prof. J. Mark Baldwin, honorary professor of the University of Mexico, formerly professor of philosophy and psychology in the Johns Hopkins University of Baltimore, has been appointed Herbert Spencer lecturer for the year 1915–16.

According to the *Korr. Norden*, lectures in the University of Berlin will be greatly reduced, on account of the number of professors and students at the front.

We learn from *Science* that under the will of the late General Charles H. Pine, recently published, Yale College will eventually receive an addition of 30,000*l.* to the 10,000*l.* scholarship fund established by General Pine about three years ago. The will also provides for the creation of a fund of 50,000*l.* to be devoted to manual training of Ansonia boys and girls. From the same source we learn that by the will of General William D. Gill, of Baltimore, the Johns Hopkins University is made residuary legatee after the death of his wife. The bequest is to be used for the establishment of a chair of forestry. The sum of 5000*l.* has been contributed by Mr. P. S. du Pont toward the University of Pennsylvania Museum extension building fund, which now amounts to more than 20,000*l.* As soon as the fund amounts to 100,000*l.*, the building of the next extension will be started.

The Civil Service Estimates for the year ending March 31, 1916, include a vote of 145,000*l.* for special grants in aid of certain universities, colleges, medical schools, and agricultural institutions, to meet loss of income arising during the war. It is pointed out that certain of the universities, colleges, and other similar institutions which are in receipt of Parliamentary grants have been adversely affected by the war, more especially by the loss of fee income arising from the widespread response among men students to the call for recruits. The special grants in aid will be used to give such assistance as may be necessary to save the institutions in question from suffering serious permanent detriment from the temporary emergency. The expenditure of the universities, colleges, and other institutions out of the grants will not be accounted for in detail to the Comptroller and Auditor-General, nor will any unexpended balances be surrendered by the payees at the close of the financial year.

Dr. H. B. Gray, formerly headmaster of Bradfield College, has recently been appointed official lecturer at the Imperial Institute in order to give short lectures on the resources of the countries of the Empire, illustrated by the collections of exhibits which are to be seen in the various courts assigned to those countries in the public exhibition galleries of the Institute at South Kensington. Since the beginning of last month a succession of such lectures has been delivered at the institute by Dr Gray, chiefly to schools in London and its neighbourhood, in connection with the school teaching of the geography of the Empire. In addition to these lectures to schools, it is now intended to arrange a weekly lecture in the exhibition galleries, of a less formal kind, for members of the general public in connection with the exhibits illustrative of the present condition and resources of the Colonies and India. The first of these lectures will be given on Wednesday, May 12, at 3 p.m., on Canada and Newfoundland, and will be followed each week in May on Wednesdays, at 3 p.m., by short illustrated lectures on other countries of the Empire in turn. A separate announcement will be made with regard to the lectures in June. No charge will be made for these lectures. Admission will be by ticket, to be obtained at the Imperial Institute, South Kensington. The number attending each lecture will be limited to fifty.

The Journal of the Institution of Electrical Engineers contains an interesting paper and discussion on training for the industrial side of engineering. The paper is by Mr. A. P. M. Fleming, who described the apprentice school which the British Westinghouse Company established a year ago at their own works. Instruction averaging about five hours a week is given during working hours to all bound apprentices, numbering altogether about 300. The regular rate of wages is paid during the time spent in this way, and the cost of books and stationery is also defrayed. Teaching is done by twelve members of the engineering staff, supplemented by lectures from the leading foremen and shop engineers. Ten of the most promising apprentices are selected each year and sent for one whole day a week to the course for engineering apprentices at the Municipal School of Technology, Manchester. Mr. Fleming emphasised the unsuitability of the evening classes in most industrial centres for "trade" instruction, which he thought was of comparatively little use to the youth who would be a workman all his life. On the other hand, he considered evening technical instruction excellent to give youths possessing ability and determination a means of rising from non-technical to technical employment. Prof. E. W. Marchant endorsed what Mr. Fleming had said with regard to evening classes, and said that it seemed to him a physical impossibility for a man engaged in manual or other labour during the day time to study effectively if he gets his technical education in the evening. On the other hand, Prof. Miles Walker, of the Manchester School of Technology, said that although day classes were better for those who could attend them, as the students would be fresher and better able to utilise their faculties, yet the men who came after their day's labour was over and did really good work three evenings a week with home lessons on Saturdays and Sundays must possess admirable qualities. Mr. J. Collinge referred to the difficulty of training young men engaged in central stations, who had not been able to afford college training, as owing to the character of the work and the hours they had to be employed they were largely prevented from regular attendance at technical schools, and consequently frequently found themselves in a "blind alley."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 22.—Sir William Crookes, president, in the chair. Lord **Rayleigh**: Deep water waves, progressive or stationary, to the third order of approximation. The principles of hydrodynamics are applied to form the equations of wave-motion to the third order of approximation without restriction other than that the motion is irrotational and in two dimensions. The results are then applied to the progressive wave of permanent form, as investigated by Stokes, and to stationary waves. It appears that the form of the latter at the moment of greatest deviation from mean level is the same as that of the permanent progressive wave, but that the periods of vibration corresponding to the same wave-length are different.—Hon. R. J. **Strutt**: A chemically active modification of nitrogen, produced by the electric discharge. VI.—Dr. C. **Chree**: The difference between the magnetic diurnal variations on ordinary and quiet days at Kew Observatory. The paper considers the difference between the diurnal variations of magnetic force at Kew Observatory on quiet days and ordinary days (*i.e.* all days with the exception of those of large disturbance). The data employed are from the eleven years 1890–1900. Taking mean data for the whole year, the difference in the horizontal plane may be regarded as consisting, to a first approximation, of a harmonic oscillation of twenty-four hour period along a direction inclined 64° east of north and of a regularly progressive non-cyclic change in a second direction which is perpendicular to the former. The result, while true of the days of the year as a whole, is only imperfectly exhibited in most individual months.—F. **Horton**: The effects of different gases on the electron emission from glowing solids. An investigation has been made of the ionisation produced by a glowing Nernst filament when used as a kathode in a discharge tube in the presence of various gases of different chemical affinities for the material of the filament. It has been found that the actual electron emission from the filament is independent of the nature of the surrounding gas, at least for the gases, air, nitrogen, oxygen, and hydrogen, for at low pressures the thermionic currents measured under similar conditions in these gases were practically the same. At higher pressures the thermionic currents differ considerably owing to the effect of ionisation by collisions being different in the different gases. The increase in the current due to ionisation by collisions in hydrogen is much greater than it is in air, oxygen, or nitrogen. The experiments were repeated with a Nernst filament covered with lime, and it was similarly found that the electron emission from lime under these conditions was not increased by hydrogen, although earlier experiments have shown that lime heated on platinum gives a much larger electron emission in hydrogen than it does in air. This appears to be caused by the hydrogen increasing the emission from the platinum, an effect which has been shown by H. A. Wilson to be due to the absorption of hydrogen by the metal. Lime and the oxides of a Nernst filament do not absorb hydrogen, and the electron emission from these substances is therefore unaltered by the presence of this gas. That the electron emission from an oxide kathode is the same in oxygen and in hydrogen, gases which have very different chemical affinities for the material of the kathode, is evidence against the theory which has lately been put forward, that the electron emission from a glowing solid is due to chemical action between the solid and the surrounding gas.—W. S. **Tucker**: Heats of dilution of concentrated solutions. More detailed study of the variation of heat of dilution with concentration is here described than has hitherto been published. Dilution was performed by short steps by addition of water at air temperature. Specific heats of solutions were accurately obtained for various concentrations so that heats of dilution could be calculated for any mean concentration. Solutions of hydrogen and lithium chlorides and sodium hydroxide give results which appear to show a linear relation with mass concentration, for the range over which heat of dilution has an appreciable magnitude. Curves are shown which indicate that this heat of dilution, if that linear relation be accepted, will vanish at such concentration as will suggest the formation of some simple hydrate of the solute. Thus the straight line connecting heat of dilution and mass concentration for hydrochloric acid solutions will, if produced, cut the axis of concentration at $HCl,15H_2O$. Solutions of lithium chloride and sodium hydroxide similarly yield hydrates $LiCl,8H_2O$ and $NaOH,8H_2O$.—T. R. **Merton**: The origin of the "4686" series. An attempt has been made to obtain some information as to the origin of the "4686" series by measurements of the relative breadths of the "4686" line and the helium lines, from which the relative masses of the atoms concerned can be calculated according to the relations which have been found by Lord Rayleigh, Michelson, Buisson and Fabry, and others. The conclusion arrived at is that either the breadth of the "4686" line is controlled by circumstances at present unknown or that the line originates from systems of subatomic mass.

Zoological Society, April 13.—Mr. E. T. Newton in the chair.—E. **Gibson**: The Ñato cattle of the Argentine. The author exhibited the skull and a photograph of some specimens formerly in his possession which he believed to be the last of the breed.—Dr. G. E. **Nicholls**: The Urostyle (*Os Coccygeum*) of the anurous Amphibia.—G. A. **Boulenger**: The snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola. The paper contained a list of all the species known to inhabit this region, with keys to the identification of the genera and species, and the descriptions of two new forms from Angola and Katanga.—Dr. R. **Broom**: Some new carnivorous Therapsids in the collection of the British Museum. Most of the specimens described have been for many years in the collection, but owing to their small size and imperfect condition they have not hitherto been recognised as new. Five species, belonging to four new genera, are Therocephalians. Two species, one of which belongs to a new genus, are Gorgonopsians, and one is a new species of a previously known Cynodont genus.—Dr. R. **Broom**: The organ of Jacobson and its relations in the "Insectivora" Tupaia and Gymnura. Gymnura is shown to have the same type as is found in Erinaceus, Sorex, and Talpa, and most higher Eutherians such as Felis, Lemur, Miniopteris, Ovis, Bos, Equus, Procavia. Tupaia, on the other hand, has, like the allied Macroscelides, the primitive marsupial type. Peters and Haeckel in 1864 and 1866 had suggested separating Tupaia and Macroscelides as a suborder of the Insectivora, but the condition of the nasal cartilages shows that the Menotyphla should form a distinct order, not even closely allied to the typical Insectivora.

Linnean Society, April 15.—Prof. E. B. Poulton, president, in the chair.—C. F. M. **Swynnerton**: Experiments and observations on the interpretation of form and coloration in plants and animals. Food-preference and other experiments were carried out over five years on insectivorous and (later) carnivorous, egg-eating herbivorous, and other animals, and numerous field-observations made. The work was attempted on a large scale and with every precaution, experiments on captive insectivorous birds were checked (and confirmed), by a series of experiments on wild birds, and various objections to a selectionist view specially tested. Numerous "deterrent" defences were found definitely to exist; also the finest gradation from those species of animals and plants that are only eaten through hunger, to the few that an individual enemy will eat to repletion-point. This indicated that the need for distinguishability from pleasanter forms (apparent and otherwise) is, and has been, widespread, and, with the numerous mistaken attacks and unmistaken refusals witnessed, suggested a contributory explanation for "distinctiveness" and diversity generally. Wild fruits were also "graded" by their eaters, and preferences shown by insects and birds as between even their own flowers; insect-hunting bird-parties were watched on a few occasions visiting exclusively particular temporarily-infested species of trees; and the utilisation of appropriate characteristics by animals for intra-specific recognition was amply illustrated by field-observation. Thus "distinctiveness" (and differentiation) may have been very widely selected in relation to "friends" too. Abundant observation of unmistaken attacks on prey and the latter's reply thereto testified to the great importance of the procryptic and actively evasive defences and to the fact of their appropriate utilisation. Moreover, enemies were seen to return expressly to stationary prey that they had not been hungry enough for on first discovery, and the view that a special handicap may prohibit conspicuousness in a group, a species, a stage, or a sex was confirmed otherwise too. That it is through the existence or development of suitable counter-agents (as flight, nauseousness, procryptic underside, and special habits) that whatever factors make for conspicuousness have been together enabled (in another species, sex, etc.) to produce it, was shown; and several such factors were indicated, including sexual selection. Animals were deterred by resemblances in prey, and a double potential basis for mimicry was found definitely to exist; also a basis for synaposematism (in flowers synepisematism) in the observed effect of the more numerous reminders and simplified recognition that a link in appearance or smell would afford. Probable cases of mimicry were seen and tested in plants, eggs, and birds. More than 800 attacks on butterflies by wild birds were witnessed. Discriminative action that might contribute to selection was actually observed at work, interspecifically (as in the preferences shown), and intraspecifically (in choice of largest available prey, destruction, or artificial entry of inconvenient ornithophilous flowers, and individual destruction through the inactivity of extra-floral nectaries).

Mathematical Society, April 22.—Sir J. Larmor, president, and afterwards Prof. Love, vice-president, in the chair.—G. H. **Hardy**: Note on Dirichlet's divisor problem.—Col. R. L. **Hippisley**: Note on a new form of closed linkage.—G. B. **Mathews**: Division of the lemniscate into seven equal parts.—Sir J. **Larmor**: The influence of the oceanic waters on the law of variation of latitude. The prolongation of the periodic time of the small free orbital motion of the pole over the earth's surface from 304 to 428 days has been recognised to be due to the centrifugal strain of the earth's rotation changing in step with the changing axis of rotation. This regular circular precession is found to be strongly disturbed by irregular surface displacements of terrestrial masses. But among these disturbances the adaptation of the ocean surface to the changing axis ought not to be included, for being synchronous with the precessional motion it must affect its period, and so fundamentally alter it instead of merely disturbing it. It is roughly estimated that if the earth were elastically unyielding, the effect of the existing ocean would be to lengthen the period of free precession from 304 to about 332 days. The remainder of the actual increase to about 428 days would be, as now, ascribed to elastic centrifugal strain of the solid earth, and the necessary slight revision of current estimates of its yielding is made on this basis. The question is broached, What would be the course of history of a planet so nearly spherical that the incumbent ocean would destroy secular stability for all possible axes of rotation?

Dublin.

Royal Irish Academy, April 12.—Rev. J. P. Mahaffy, president, in the chair.—Rev. P. **Browne**: An integral equation proposed by Abel, and other functional equations related to it. The paper deals principally with the equation, $\int_a^b G(t)f(tx)dt = g(x)$, where G and g are known functions, and f is to be discovered; a and b are constants. Abel gave this equation as a generalisation of the problem of the isochrone, stating he had solved it, but the solution does not appear in his published works. A solution is found involving integration along an infinite straight line in the plane of the complex variable. By extensions of the method, the equations,

$$\int_b^a G(x, t) f(tx)dt = g(x), \quad \int_0^{r}\int_0^{t} G(t, \tau) f(tx, \tau y) dt d\tau = g(x, y),$$

and others, are solved.—A. J. **Rahilly**: Some geometrical determinants. The geometrical determinants dealt with are of the type exemplified in Frobenius's theorem connecting the mutual powers of two quintets of circles. It is shown by a very simple method that similar determinantal relations exist between many sets of geometrical entities; in fact, a large part of the metric geometry of the point, line, circle, plane, and sphere may be reduced to such determinant-equations. Some new applications are given; in particular, Ptolemy's theorem, which is a special case, is given several extensions.

Royal Dublin Society, March 23.—Prof. W. Brown in the chair.—Prof. J. **Wilson**: Simplified solutions of certain Mendelian problems in which factors have inseparable effects. The author makes use of two simple observations to prove certain problems discussed in a previous paper on unsound Mendelian developments. The observations are:—(1) If one or more groups in a set of hybrids' progeny carry a character outside those producing the set, that character is common to all the groups in the set. For instance, if the characters carried by the four following groups have been found as set down, namely: agouti, 9XY; cinnamon agouti, 3Xy; black, 3xYZ; chocolate, 1xy; then the character Z is carried by the three remaining groups, for otherwise black would differ from agouti and chocolate in more than one pair of characters, and from cinnamon agouti in more than two. (2) A character carried by more than half the groups in a set of hybrids' progeny is common to all the groups in the set. For instance, if the characters of three of the four groups in a set have been found as follows: agouti, 9XYZ; dilute agouti, 3; black, 3xYZ; blue, 1xYz; then dilute agouti must also carry Y, and, by the symmetry of the set, the additional characters X and z.—Miss A. **Wilson**: Changes in soils brought about by heating. The increased productivity of soil which has been subjected to different degrees of heat has been studied by E. J. Russell and F. J. Seaver and E. D. Clark. Russell suggests that the increased productivity is due to the increase in the number of nitrifying bacteria consequent on the destruction of the larger organisms by heat. Seaver and Clark and others maintain that the heated soil owes its greater productivity to the increased amount of soluble matter due to the decomposition of soil constituents. In these experiments extracts of suitably prepared soil heated to various temperatures between 60° and 150° during periods of two hours were obtained. The depression of freezing point and the electrical conductivity of each solution were then determined. It was found that there was a marked range in the coloration of the solutions thus obtained, and each solution gave a marked reaction to litmus. The amount of water retained by the heated soil was also noted in one set of experiments, and found to increase with the temperature to which the samples were heated. Throughout the experiments the depression of freezing point and electrical conductivity showed a marked increase in the solutions obtained from samples heated at the higher temperatures.

Paris.

Academy of Sciences, April 19.—M. Ed. Perrier in the chair.—A. **Müntz** and E. **Lainé**: Studies on the agricultural value of the sediments carried by the watercourses of the Alps and Pyrenees. From the chemical point of view, these sediments have nearly the same proportions of fertilising materials as good average arable soils. They vary greatly in physical properties and measurements were made of the apparent density, porosity, capacity for water, and permeability of sediments from different sources. The permeability varies greatly, and the fine sediments tend to choke the irrigated soil. Experience has shown agriculturists making use of irrigation the best means of dealing with this tendency to impermeability.—C. **Guichard**: A series of surfaces and the equations of Laplace which are reproduced by a transformation (m, n) of Darboux.—V. **Grignard** and Ch. **Courtot**: Benzofulvanol and benzofulvene. Starting with the magnesium compounds of *cyclo*pentadiene, indene, and fluorene, and treating these with aldehydes and ketones, secondary and tertiary alcohols are obtained which have been named fulvanols, benzofulvanols, and dibenzofulvanols, and these, by dehydration, give the corresponding hydrocarbons. The preparation is described of the benzofulvanol obtained from indene magnesium bromide and trioxymethylene and the hydrocarbon benzofulvene obtained by its dehydration.—M. **Riquier**: Partial linear systems composed of equations equal in number to those of their unknown functions.—Rodolphe **Soreau**: Circular anamorphosis.—Pierre **Humbert**: The piriform figure of equilibrium of a fluid mass. Prof. Poincaré and Sir G. H. Darwin came to opposed conclusions as to the presence of points of inflexion on the section by a symmetrical plane of the equilibrium figure of a fluid mass in rotation. The author concludes that there are no points of inflexion and the calculations of Poincaré, pushed to the end, lead to the same result as those of Darwin.—B. Globa **Mikhaïlenko**: Modification of the ellipsoidal figures of equilibrium of a fluid mass in rotation under the action of capillary pressure.—M. **Drzewiecki**: Wind motors.—A. **Leduc**: The velocity of sound in gaseous mixtures. The application of a formula deduced in a previous communication to consideration of the velocity of sound in moist air, carbonic acid (Regnault's experiments), and mixtures of air and methane. The deviations between experiment and the author's theory are explained by the assumption that the latter is correct and that the gases used by Regnault and Capstick were impure.—Daniel **Berthelot**: The kinetics of photochemical reactions.—Ch. **Courtot**: The theory of the oscillation of the indene double linkage. The theory put forward by Thiele to explain his experimental results is unnecessary, since owing to an isomeric change unperceived by him he was dealing with only one benzylindene, the γ compound. The α-benzylindene has been prepared by the author, and is shown to be distinct.—M. and Mme. Fernand **Moreau**: Nuclear evolution and the phenomena of sexuality in the lichens of the genus Peltigera.—M. **Fonzes-Diacon**: Copper spraying fluids. The acid fluids have a high anticryptogamic action, the neutral and alkaline solutions are less active.

BOOKS RECEIVED.

Elementary Text-book of Economic Zoology and Entomology. By Prof. V. L. Kellogg and Prof. R. W. Doane. Pp. x+532. (New York: H. Holt and Co.) 1.50 dollars.

The Fauna of British India, including Ceylon and Burma:—Mollusca (Freshwater Gastropoda and Pelecypoda). By H. B. Preston. Pp. xix+244. (London: Taylor and Francis.) 10s.

Electrical Instruments in Theory and Practice. By W. H. F. Murdoch and U. A. Oschwald. Pp. viii+306. (London: Whittaker and Co.) 10s. 6d. net.

The Development and Properties of Raw Cotton. By W. L. Balls. Pp. xii+221. (London: A. and C. Black.) 5s. net.

Militarism versus Feminism. Pp. 64. (London: G. Allen and Unwin, Ltd.) 6d. net.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Edited by G. H. Warburton. Fifth edition, in 3 vols. Vol. iii. Pp. viii+483. (London: Macmillan and Co., Ltd.) 20s. net.

"Red Books" of the British Fire Prevention Committee. No. 196: Fire Tests with Glass. The Committee's Report. Pp. 20. No. 197: The Committee's Report. Pp. 16. (London: British Fire Prevention Committee.) 2s. 6d. each.

Heredity and Environment in the Development of Men. By Prof. E. G. Conklin. Pp. xiv+533. (Princeton: University Press; London: Oxford University Press.) 8s. 6d. net.

Histoire de l'Involution Naturelle. By Dr. H. Marconi. Pp. xii+505. (Paris: A. Maloine; Lugano: Maison d'Editions du "Cœnobium.") 15 francs.

Towards Racial Health. By N. H. March. Pp. ix+326. (London: G. Routledge and Sons, Ltd.) 3*s*. 6*d*. net.

Journal of the Natural History and Science Society of Western Australia. Vol. v. Pp. 109. (Perth, W.A.: V. K. Jones and Co.) 2*s*. 6*d*.

Castration of Domesticated Animals. By Profs. F. S. Schoenleber and R. R. Dykstra. Pp. x+154. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd.) 1.25 dollars net.

The Syrphidæ of the Ethiopean Region based on Material in the Collection of the British Museum (Natural History), with Descriptions of New Genera and Species. By Prof. M. Bezzi. Pp. 146. (London: Longmans and Co., and others.) 6*s*.

Catalogue of the Amatidæ and Arctiadæ in the Collection of the British Museum. By Sir G. F. Hampson. Plates i.-xli. (London: Longmans and Co., and others.) 1*l*. 13*s*. 6*d*.

British Museum (Natural History). Instructions for Collectors. No. 12. Worms. Pp. 23. (London: British Museum, Natural History.) 3*d*.

A Revision of the Ichneumonidæ based on the Collection in the British Museum (Natural History), with Descriptions of New Genera and Species. Part iv. Tribes Ioppides, Banchides, and Alomyides. By C. Morley. Pp. x+167. (London: Longmans and Co., and others.) 6*s*.

Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History). Vol. iii. By G. A. Boulenger. Pp. xii+526. (London: Longmans and Co., and others.) 2*l*. 5*s*.

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology. Vol. ii. No. 4. Pp. 61–112. Mollusca. Part 1. By E. A. Smith. (London: Longmans and Co., and others.) 4*s*.

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology. Vol. i. No. 3. Pp. 85–124. Cetacea. By D. G. Lillie. (London: Longmans and Co., and others.) 7*s*. 6*d*.

Chinese Forest Trees and Timber Supply. By N. Shaw. Pp. 351. (London: T. Fisher Unwin.) 10*s*. 6*d*. net.

Photomicrography. Third edition. Pp. 36. (London: Kodak, Ltd.) 3*d*.

A History of Persia. By Lieut.-Col. P. M. Sykes. 2 vols. Vol. i. Pp. xxvi+544. Vol. ii. Pp. xxii+565. (London: Macmillan and Co., Ltd.) 50*s*. net.

DIARY OF SOCIETIES.

THURSDAY, April 29.

Royal Society, at 4.30.—The Transmission of Infra-red Rays by the Media of the Eye, the Transmission of Radiant Energy by Crookes's and other Glasses, and the Radiation from various Light Sources: H. Hartridge and A. V. Hill.—Surface Tension and Ferment Action: E. Beard and W. Cramer.—Surface Tension as a Factor controlling all Metabolism: W. Cramer.

Royal Institution, at 3.—Advances in General Physics: Prof. A. W. Porter.

Institution of Electrical Engineers, at 8.—The Bombay Hydro-Electric Scheme: A. Dickinson.

Zoological Society, at 4.—Anniversary Meeting.

FRIDAY, April 30.

Royal Institution, at 9.—Emulsions and Emulsifications: Prof. F. G. Donnan.

Institution of Petroleum Technologists, at 8.—Oil Well Engineering: W. Calder.

SATURDAY, May 1.

Royal Institution, at 3.—Photo-Electricity: Prof. J. A. Fleming.

MONDAY, May 3.

Royal Society of Arts, at 8.—Foodstuffs: Dr. D. Sommerville.

Victoria Institute, at 4.30.—Mahâyâna Buddhism and Christianity: Rev. Dr. W. St. Clair Tisdall.

Aristotelian Society, at 8.—Maine-de-Biran: Prof. A. Robinson.

Society of Chemical Industry, at 8.

TUESDAY, May 4.

Royal Institution, at 3.—The Animal Spirits: Prof. C. S. Sherrington.

Royal Society of Arts, at 4.30.—The Empire's Resources in Paper-making Materials: S. C. Phillips.

WEDNESDAY, May 5.

Society of Public Analysts, at 8.—*Discussion:* Methods adopted in the Estimation of the Nitrogenous Constituents of Extracts derived from Albuminous Substances, such as Meat Extracts and Similar Products, with Special Reference to the Interpretation of the Results.

Royal Society of Arts, at 8.—The Measurement of the Efficiency of Domestic Fires, and on a Simple and Smokeless Grate: Dr. A. V. Harcourt.

Entomological Society, at 8.—Descriptions of South-American Micro-Lepidoptera: E. Meyrick.—Experiments on Carnivorous Insects: C. F. M. Swynnerton.—The Larva and Pupa of *Caligo memnon*, Feld: F. L. Davis.

THURSDAY, May 6.

Royal Society, at 4.30.—*Probable Papers:* Some Problems Illustrating the Forms of Nebulæ: G. W. Walker.—Observations on the Resonance Radiation of Sodium Vapour: Hon. R. J. Strutt.—Local Differences of Pressure near an Obstacle in Oscillating Water: Hertha Ayrton.—Measurement of the Specific Heat of Steam at Atmospheric Pressure and 104·5° C. (with a Preface by Prof. H. L. Callendar, F.R.S.): J. H. Brinkworth.—Thermal Properties of Carbonic Acid at Low Temperatures. II.: C. F. Jenkin and D. R. Pye.

Royal Institution, at 3.—Advances in General Physics: Prof. A. W. Porter.

Royal Society of Arts, at 4.30.—Constantin Meunier et les Sculpteurs Belges de son Temps: M. Paul Lambotte.

Linnean Society, at 5.—Some Bird Problems: W. Percival Westell.—The Brown Seaweeds of the Salt-marsh: II.: Dr. Sarah M. Baker and Miss M. H. Bohling.—A Collection of Borneo Mosses made by the Rev. C. H. Binstead: H. N. Dixon.—Photographs of a Curiously-grown Tree from a Tunbridge Wells Garden: Rev. T. R. R. Stebbing.

FRIDAY, May 7.

Royal Institution, at 9.—Electrons and Heat: Prof. O. W. Richardson.

Geologists' Association, at 8.—Radio-activity and the Measurement of Geological Time: A. Holmes.

SATURDAY, May 8.

Royal Institution, at 3.—Photo-Electricity: Prof. J. A. Fleming.

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THURSDAY, MAY 6, 1915.

THE TECHNOLOGY OF ILLUMINATION.

Modern Illuminants and Illuminating Engineering. By Leon Gaster and J. S. Dow. Pp. xiv + 462. (London: Whittaker and Co., 1915.) Price 12*s.* 6*d.* net.

WHEN a new branch of science, art, or industry becomes recognised, the literature on the subject might at first be expected to be scant in quantity and meagre in scope. But illuminating engineering is a new branch only in so far that attempts have been made to collect and arrange scattered facts and principles, and very few individuals call themselves illuminating engineers. So far as means, methods, and appliances for producing artificial light are concerned, the new movement has done little else than to record ancient and modern practice, but certain advances have been made on the scientific side by the development of photometry, and the extension of theoretical considerations of the distribution of illumination which are not to be found in text-books on optics. Some attention has been given to the subject of "glare" which is difficult to define, and to the artificial production of light not differing visually from ordinary daylight.

Having regard to the keen rivalry between the advocates of gas and of electric lighting, the success of an illuminating engineering society at one time appeared to be doubtful. It was founded in 1909, and has as its official journal the *Illuminating Engineer.* The membership has reached nearly five hundred, and many useful papers and discussions have resulted. This has been largely due to the tact and zeal of Mr. L. Gaster and Mr. J. S. Dow, the editors of the journal and the secretaries of the society. Even if the former of these were not a linguist or had a taste for antiquarian research and a genius for bringing competitors into harmony, and if the latter were not trained in physics and had not done any original work in photometry, they would have been in possession of a vast amount of material for a book, and well qualified to use it.

In accordance with the traditional opening of a Friday evening discourse at the Royal Institution, the first chapter begins with "the very earliest conceptions of light" in remote antiquity, and its use "among primitive peoples," and runs through history up to the Home Office Departmental Committee on Illumination, and the formation of the International Photometric Commission. The second chapter deals with gas burners, and does not touch on the chemistry or the making of gas. The section on high-pressure gas is compressed into only about five pages. The third gives as much on electric lighting can be packed into thirty-six pages, while the fourth describes oil, petrol-air gas, and acetylene lighting. These constitute one-third of the book, and appear at first to be of a sketchy character, but almost every page has foot-notes, and most of these refer to English and foreign periodical literature. A bibliography is provided at the end, but it does not include more than a small portion of the publications referred to in the valuable foot-notes.

The fifth and sixth chapters on the human eye and colour vision are a useful epitome. The last half of the book consists of chapters on the measurement of light and illumination, shades and reflectors, problems of interior and of outdoor lighting. These are well illustrated by reproductions of photographs, many of which have appeared in the *Illuminating Engineer.* Although this does not profess to be a treatise or even a text-book, an omission or two must be noticed. Polar curves are given in considerable numbers, and the solitary place in which an integral expression is used warns the reader against a common mistake which is sometimes made in deducing mean spherical candle-power from such a curve. "The well-known Rousseau method," which achieves this result graphically, is not described or even foot-noted, but is merely alluded to. The Ulbricht globe which is experimentally used for the same purpose has a full-page illustration and a foot-note with eight references, but only eleven lines are allowed for a description of it. Prof. Clinton has shown that the illumination of a room may be pre-determined by calculation, and possibly his treatment was not suitable for a book of this type, but, on the other hand, there are several rule-of-thumb methods and tables for finding how many lamps or how much candle-power or flux in lumens are required for interior work, and some of these might have been included. An American trading concern cannot perhaps be blamed for giving the name "X ray" to a type of reflector, but it should not be mentioned without a disparaging "so-called."

The subject is still developing so rapidly that it must have required some courage to produce a volume of this kind, and it is so wide that to decide the proportion to be allowed to different sections must have been a matter of difficulty. Such questions of proportion are necessarily matters of opinion, and books, after all, are what publishers allow authors to offer us, and not what the reviewers think or even what the readers may desire that they should be. Some would like more mathematics, others data on economical points. The authors have succeeded admirably in the task which they have set themselves, and the book is well produced.

L

PLANT LIFE IN ICELAND AND CYPRUS.

(1) *The Botany of Iceland.* Edited by Dr. L. K. Rosenvinge and Dr. E. Warming. Part I. 2. An Account of the Physical Geography of Iceland, with special reference to the Plant Life. By Prof. Th. Thoroddsen. Pp. 191–343. (Copenhagen: J. Frimodt; London: J. Wheldon and Co., 1914.)

(2) *Bergens Museums Skrifter. Ny Raekke.* Bind i., No. 2. Studies on the Vegetation of Cyprus. Based upon Researches during the Spring and Summer, 1905. By Jens Holmboe. Pp. 344. (Bergen: John Griegs, 1914.)

(1) THE present instalment of "The Botany of Iceland," by Prof. Thoroddsen contains five chapters. The first chapter deals with general topography and geology. The island is a continuous table-land with an average height of 700–1000 metres above sea-level, excepting narrow borders of coastal land, valleys which cut into the table-land on all sides, and a few small areas of level land towards the south and west. More than two-thirds of the entire area is at so great a height above sea-level that almost no vegetation can thrive there. The sandy and stony deserts of the interior plateau, the lava tracts, and the glaciers are not fit dwelling-places for man, and it is almost exclusively, therefore, the coasts and valleys which are inhabited. The volcanic element is the most striking feature in the geology, and is treated at some length.

The second chapter deals with conditions of surface and soil. Basalt is the fundamental rock; the tuffs and breccias are for the most part basalt split and pulverised, and the mineralogical and chemical component is essentially the same throughout the island. The climate, discussed in chapter iii., is, owing to oceanic currents, much milder than would be expected from the position of the island. Evidence of the Gulf Stream is found in the drift material, which includes sugar-cane and seeds of *Entada* and other West Indian beans. The winter is long, but generally not severe; the summer is comparatively short and cold and the weather usually changeable and damp.

The general distribution of plant life and a sketch of the chief plant-formations form the subjects of the remaining two chapters. Only a small part of Iceland bears a continuous carpet of vegetation. The number of species of flowering plants and ferns is from 400 to 450, as compared with 380 in Greenland and about 1450 in Denmark. Of these eighty-four are grasses and sedges. Man, with his sheep and cattle, has exercised considerable influence on the vegetation. The coppice woods of birch (*Betula odorata*) which were once extensive are rapidly disappearing, and their destruction has affected the general vegetation. The nature of the country and the vegetation are well illustrated by a number of photographic figures.

(2) The detailed study of the botany of Cyprus is the result of a desire on the part of a Norwegian botanist to compare with the flora of his own country that of an area in which there had been no glacial epoch. The author gives a brief sketch of the topography, geology, and climate of the island, and a short history of our knowledge of the flora, including a list of plants mentioned by authors before 1787. The main part of the volume is devoted to a carefully annotated systematic list of the vascular plants hitherto observed spontaneously growing in Cyprus, and some remarks on the most important plant-societies of the island. During his seven months' stay the author was able to add considerably to the number of plants previously recorded, and also to study critically various elements of the flora. The cedar of the island he regards as a distinct endemic sub-species, with affinities partly with the cedar of Lebanon and partly with that of the Atlas range. Several new species of flowering plants are described, and these as well as many others of special interest are illustrated by excellent plates and text-figures.

Large deposits of calcareous tufa were discovered containing excellent leaf-impressions consisting mainly of *Laurus nobilis* and *Platanus orientalis*, with fragments of *Ficus carica*, *Smilax aspera*, and *Rhamnus oleoides*, all of which are represented in the present-day flora. The account of the plant-societies, though not exhaustive, is a valuable contribution, greatly enhanced by a number of photographic reproductions. There are also short chapters on the means of distribution of some of the plants and on the affinities and history of the flora; also a list of topographical names derived from plant names, and a bibliography.

PRIME NUMBERS AND THE COMPLEX VARIABLE.

(1) *List of Prime Numbers from* 1 *to* 10,006,721. By D. N. Lehmer. Pp. xv+133. (Washington, D.C.: Carnegie Institution of Washington, 1914.) Price 5 dollars.

(2) *Functions of a Complex Variable.* By Prof. J. Pierpont. Pp. xiv+583. (London: Ginn and Co., 1914.) Price 20*s.* net.

(1) THE table is similar in form to Mr. Lehmer's previously published factor-table (see NATURE, August 10, 1911, p. 178), and the same elaborate precautions have been taken to avoid error. Thanks to the work of Glaisher and

his predecessors, we may now be fairly confident that the primes in the first nine millions have been correctly determined; the introduction to the present table describes the checks used for the tenth million, and contains other very interesting matter. First we have an account of Kulik's remarkable work, which, although not accurate, has been found to be of great value as a check, and actually goes beyond 100,000,000; unfortunately the second of the eight MS. volumes is missing. Then we have an admirable summary of the work done in the theory of the distribution of primes, ending with Gram's series, which is a transformation of Riemann's celebrated formula. Finally we have a table, at steps of 50,000, giving comparisons of the actual count with the values found from the formulæ of Legendre, Tchébicheff, and Riemann respectively.

The superiority of the last-named becomes more and more evident the further we go; the errors fluctuate in sign, and their ratios to the true value diminish in a most remarkable manner. The error is actually zero for a table going from 1 to 9,050,000; and for 10,000,000 it is only +87, the number of primes, as counted, being 664,580. The errors in the other two calculated values are always in excess and Legendre's value is less accurate than the other; but the comparative smallness of the errors is noteworthy, being only 560 and 338 respectively for a ten-million table. Perhaps there may be a simple modification of Legendre's formula which would bring it into closer agreement with Gram's.

The liberality of the Carnegie Institution of Washington has made it possible to publish this table at a price which is remarkably low, considering the labour involved. We hope that English universities and colleges will provide themselves with copies, and make an announcement that they have done so; this would be a great benefit to scattered arithmeticians, who now and then wish to know whether a particular number is prime or not, and may not be able to afford even a sovereign for the luxury of possessing this work. The same thing may be said, with greater emphasis, about the factor-table.

(2) Prof. Pierpont's treatise on the complex variable is very good, and a judicious mean between elaborate works addressed to the expert and specious outlines which ignore all difficult points, and tempt the reader to draw all sorts of false conclusions. The method is practically that of Cauchy, as developed by Briot and Bouquet, and Hermite, no use being made of Riemann surfaces. On the whole, we think this is the preferable course, because, although in simple cases the Riemann surface provides a visual image of great simplicity, and is invaluable for purposes of research, we cannot *construct* it until we have worked out the analytical theory of the algebraic functions we are considering, and this comes to discussing a system of Cauchy loops.

Readers of Dedekind and Weber's memoir on algebraic functions will remember that the authors laid great stress on the precise meaning of "a point on a Riemann surface"; this is the main crux of the whole theory, and another way of putting it is to determine the complete characteristics of a singular point on a given algebraic curve. This last way was that of H. J. S. Smith and Halphen. The present writer is no doubt prejudiced; but he ventures to say that in his opinion Dedekind's notion of algebraic divisors, as expounded, for instance, in Hensel and Landsberg's treatise on algebraic functions, is the best way to express the analytical facts in a concise symbolical form. For one thing, it brings into prominence the idea of a compound modulus, which is bound to lead eventually to a great simplification of the theory of algebraic functions.

A good feature of the treatise is that special functions such as those of Legendre and Bessel, and the hypergeometric function and elliptic functions, are treated in the light of the general theory.

There are two points about which the author might have written differently with advantage. It is not correct to say that the argument (amplitude) of $x+yi$ is $\tan^{-1}y/x$; otherwise we should have $\arg(x+yi)=\arg(-x-yi)$. The author does not say this, but (p. 11) he invites this false conclusion. The correct statement may be written—

$$\arg(x+yi)=(\sin, \cos)^{-1}(y/r, x/r),$$

where $r=+\sqrt{(x^2+y^2)}$, and $(\sin, \cos)^{-1}(a, b)$ means an angle of which a is the sine and b is the cosine.

Thus $\arg(x+yi)$ is determinate up to multiples of 2π; and this is the only way to avoid error arising from the definition.

The second point is this. Suppose we have two infinite series—

$$s=a_1+a_2+a_3+ \ . \ . \ .$$
$$s'=b_1+b_2+b_3+ \ . \ . \ .$$

of such a nature that $a_i=b_j$, where i is uniquely determined by j and conversely, we can define s' as a *permutation* of s, on the ground that every term of s' occurs in s and conversely. But it does not follow that the sum of s' is equal to the sum of s, even though both are convergent. We are, however, able to say that if s is absolutely convergent, and s' is such a permutation of s that the relation $b_j=a_i$ makes j finite whenever i is finite, and conversely, then s' is absolutely convergent, and its sum is equal to that of *s*. The essential thing is to note that an infinite series is defined not only by its terms, but by the order in which they are written. The author fails to emphasise the fact that in dealing with permutations of series we must keep any term in a finite place in a finite place. G. B. M.

FARM MANAGEMENT AND RURAL IMPROVEMENT.

(1) *Soil Management.* By the late Dr. F. H. King. Pp. ix+311. (New York: Orange Judd Co.; London: Kegan Paul, Trench, Trübner and Co., 1914.) Price 1.50 dollars.

(2) *Hunt and Burkett's Agriculture: Farm Animals, covering the General Field of Animal Industry.* By Prof. T. F. Hunt and Prof. C. W. Burkett. Pp. ix+534. (New York: Orange Judd Co.; London: Kegan Paul, Trench, Trübner and Co., 1914.) Price 1.50 dollars.

(3) *A Handbook for Farmers and Dairymen.* Sixth edition. By Prof. F. W. Woll. Pp. xvi+490. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 6*s*. 6*d*. net.

(4) *Rural Improvement: the Principles of Civic Art Applied to Rural Conditions, including Village Improvement and the Betterment of the Open Country.* By F. A. Waugh. Pp. xi+265. (New York: Orange Judd Co.; London: Kegan Paul, Trench, Trübner and Co., 1914.) Price 1.25 dollars net.

(1) THE book on soil management, which has been prepared from various notes and lectures of the late Dr. King, bears eloquent testimony, not only to his wealth of knowledge of the subject he had made so thoroughly his own, but also to much painstaking inquiry into the systems of agriculture and soil treatment in China, Korea, and Japan. Much of the book is naturally devoted to the consideration of productive capacity as determined by water supply, soil structure, and the physical features of the soil generally, and also contains many original observations on the effect of cultivation, mulching, and drainage. Teachers of agricultural science in this country will not fail to find much useful matter and many apt illustrations in this portion of the book. Not the least valuable portion of the work, however, will be found in those pages descriptive of the practices adopted in the Far East, by means of which soil fertility has been conserved to such a remarkable degree that a greater number of people are fed per unit area than in any other country in the world. Strict economy of all fertilising material is the main consideration, but the practical experience of centuries of Asiatic agriculture has evolved modes of conservation, fermentation, and crop production in respect to which we stand, at the present day, merely on the fringe of investigation.

(2) The perusal of Messrs. Hunt and Burkett's book on farm animals leaves one with a number of dissimilar impressions. The work is primarily intended for use by high-school pupils of fourteen to eighteen years of age, and aims at providing a survey of the whole range of animal industry. The scope of the book is certainly wide enough for all ordinary requirements, and there seems to be no reason to doubt that by a process of judicious mental winnowing sufficient concrete impressions may be obtained to impart an intelligent recognition of the issues upon which successful husbandry depends. A number of admirable practical exercises constitute the most valuable portion of the book, but one is inclined to deplore the inclusion of matter such as the first lesson on the "sorting of animals" and the apparent lack of discrimination in respect to many illustrations of the kindergarten type.

(3) Prof. Woll's handbook comprises in tabular form many of the data of value in agriculture generally, and dairying in particular, and the fact that it is now in its sixth edition may be taken as evidence of the useful function it is performing. The various sections, *e.g.*, those on farm animals, poultry, veterinary science, seeds, weeds, farm pests, forestry, etc., are prefaced by short articles by American authorities, and give an excellent digest of the subject. A certain proportion of the data bears, of course, reference to American conditions only, but the majority of the subject-matter will be found useful by English and colonial readers. Most of the tables are taken from trustworthy sources, and only one or two of doubtful authenticity have crept in. It is perhaps a matter for regret, from an agricultural point of view, that soils have not received any attention.

(4) Although much of the attention of the dweller in American rural districts has, in times past, been occupied by the necessity of making both ends meet, signs are not lacking at the present time that the main problem now is "not how to make more money, but how to live more comfortably." Whilst the value of co-operation in the purchase and sale of commodities, however, has been extensively realised, that of common effort in the development of civic life and institutions has not received the attention which it must ultimately do, and Mr. Waugh in his interesting book on rural improvement makes a strong plea for the appreciation of civic art—the art that builds a sound physical frame for the

support of a healthy community life. Even if the American farmer is indifferent to the appeal for better surroundings as set forth in these pages, many of the problems discussed demand consideration on account of their economic importance. In the matter of roads, for instance, only 8 to 9 per cent. of the total roads of the States have been improved by surfacing with gravel, oyster shells, etc., whilst the remainder are often so despicably bad that the cost of haulage of farm products is three to four times the legitimate amount. The one-street town is passing away, and many of the suggestions advanced by Mr. Waugh as to farm and town planning are well worthy of practical adoption.

TEXT-BOOKS OF PHYSICS.

(1) *Cours de Physique.* By Prof. E. Rothé. Pp. vi+183. (Paris: Gauthier-Villars et Cie, 1914.) Price 6.50 francs.

(2) *Traité de Physique.* By Prof. O. D. Chwolson. Translated by E. Davaux. Pp. vi+266. (Paris: A Hermann et Fils, 1914.) Price 9 francs.

(3) *Preliminary Practical Science. Some Fundamental Principles of Physical Science, with their Practical Applications.* By H. Stanley. Pp. viii+128. (London: Methuen and Co., Ltd., n.d.) Price 1*s.* 6*d.*

(4) *Outlines of Applied Physics.* By H. Stanley. Pp. viii+227. (London: Mills and Boon, Ltd., 1914.) Price 2*s.* 6*d.*

(5) *Preliminary Practical Physics.* Part ii. *Heat.* By A. E. Lyster. Pp. vii+73. (Dublin: Educational Co. of Ireland, 1914.) Price 7*d.* net.

(6) *A School Electricity.* By C. J. L. Wagstaff. Pp. xi+250. (Cambridge: At the University Press, 1914.) Price 5*s.* net.

(7) *Elementary Geometrical Optics.* By A. S. Ramsey. Pp. xi+173. (London: G. Bell and Sons, Ltd., 1914.) Price 6*s.*

(1) AS judged by the size of the first two books of the "Cours de Physique," which Prof. Rothe is writing, the whole work will be of very considerable magnitude. According to the author's foreword, these two books represent the introduction only to the course itself, which is intended for students who have already studied physics, and primarily for those who are proceeding to technical institutes. In several ways this introduction is rather remarkable. The subjects covered in the first book are (i) units, and their transformation from one system to another; (ii) the principle of similitude in physics; and (iii) methods of measuring the fundamental physical quantities, and the errors involved. In the second book, the statics of fluids and the experimental measurement of densities and pressures are dealt with. There is, perhaps, too little stress laid upon theory, but there can be no doubt that the detailed descriptions of the methods of measurement with great precision, together with the diagrams illustrating these methods, are in every way excellent.

(2) Many physicists regard Prof. Chwolson's treatise on physics as the best in existence—and with justice. Prof. Chwolson has not only given us a most complete and accurate survey of experimental physics in practically all its branches, together with an exhaustive bibliography, but he has also contrived to make his work a critical essay. The translation of this work into French, making it—as it will do—available to those students who do not know Russian and read German with difficulty, is a most desirable event. That now published is the tenth part, and contains the chapters on electromagnetic induction, Maxwell's theory, the basis of electronic theory, and the principle of relativity. The translation has the advantage of having been revised by the author himself, who has, at the same time, considerably augmented the edition. The chapters on the theories of electrons and relativity have, consequently, an added interest, and it will be found that they give a very comprehensive survey of these subjects which are at present so much under discussion.

(3) This little volume adds another to the already large number of similar books which have been published within recent years, and follows much the same lines of treatment. A considerable number of simple physical experiments are described, principally in mechanics, heat and light, those in electricity and magnetism numbering only half-a-dozen. Each exercise combines a simple statement of the theory of the experiment and a description of the method of procedure. In some of them, however, the results obtained would not be what the student is led to expect. For example, in the experiment on the spectrum, no lens is used to focus the light on the screen, and we are told incidentally that the spectrum consists of *seven* colours. A refreshing feature of the book, however, consists of some excellent notes on experimental work which, if all students would follow, would bring about a great improvement in their practical records.

(4) In the main, this book is a series of examples in theoretical physics, for not only are there numerous numerical exercises at the end of each chapter, but more than four hundred of a miscellaneous character at the end of the book. The work, as the author himself points out, is

in no way descriptive, and therefore could not serve as a text-book. Indeed, it seems rather to partake of the "cramming" nature, and would tend to make physics appear to consist of a series of mathematical formulæ. Still, provided that it does not lead students to neglect the experimental side of physics, the book will probably be found quite useful.

(5) This is a little paper-covered pamphlet containing descriptions of some forty simple experiments in heat, and, although small, is well printed and arranged. The diagrams all represent *sections* of the apparatus, and are free from elaborate details. This is a good feature, for, as the author points out, it will encourage the reader to do the same in his practical records, instead of wasting time over sketching the exact apparatus—a thing which but few students can do well.

(6) It is not often that there appears a physical text-book so generally good as this one of Mr. Wagstaff. It is the outcome of the author having been persuaded to publish a book comprising the notes of his lectures at Oundle School, and he is to be congratulated on the result. Not only is the treatment obviously based upon experience in teaching the subject, but the descriptive work and the methods of explaining those parts of the theory which present difficulties to the average student have an originality which is very refreshing. Besides this, all the diagrams and plates are excellent, and these features, together with the good printing of the text, give the book a general appearance which is very pleasing. One or two criticisms may be made. These, however, detract but little from the value of the book. The first is with reference to the definition of the ampere in terms of silver deposited during electrolysis. One knows, of course, that it is so defined by law, but it cannot be clear to a student why the special amount, 0·001118 gram per second, is chosen. In fact, we disagree entirely with the position which the author advocates in his preface, viz., that it is desirable to begin teaching current electricity using direct reading instruments such as ammeters, instead of by means of the tangent galvanometer, which, besides having a mode of action which is simpler than that of an ammeter, serves also to measure the current absolutely.

In the second place, the study of electrostatics and magnetism ought to be taken earlier than it is in this book. The book opens with a very short chapter on magnetism, then proceeds with current electricity, and the treatment proper of magnetism and statical electricity is not reached until half-way through. It would, however, be possible for these chapters to be read first, and the objection would thereby be partially removed. In any case, it is not of great importance, and the book is to be thoroughly recommended.

(7) This book, also, is well produced, and deals with a subject somewhat neglected. Although the treatment is not advanced, it comprises a wide field, including the important subjects of achromatism, thick lenses, and optical instruments. There are frequent examples which will, no doubt, be useful for training the students. It is quite certain that there has been for some time an opening for a book of this kind, and the present volume is well fitted to supply the demand which exists. In fact, students of the subject of light would be well advised to read this volume in conjunction with their text-books of physical optics; and those who intend becoming optical instrument makers would benefit greatly by studying it.

OUR BOOKSHELF.

Œdema and Nephritis: a Critical, Experimental, and Clinical Study of the Physiology and Pathology of Water Absorption in the Living Organism. By Prof. M. H. Fischer. Second edition. Pp. x+695. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 21*s.* net.

THIS is the second edition of a work which has already attracted some attention in the physiological world. The author's main theme is that dropsy is not due to disorders of the circulation, or to changes in osmotic processes, but is wholly produced by the tissues themselves sucking up water from the blood, and that increase in acidity of the tissues is the sole factor in their being able to attract more water into their colloid structure. The main experiments upon which this theory depends were performed by placing dead frogs' legs and pieces of gelatin in fluids of different composition and reaction. Even the swelling which occurs in a limb when reflux of blood from it is prevented by occluding the veins is explained on the acid theory. Addition of such salts as sodium chloride to the experimental fluid lessens the amount of swelling; yet it is well known that excess of such salts favours dropsy during life. This is ingeniously explained by saying that the excess of salt lessens vital oxidative processes, and this leads to formation of acid, and therefore indirectly to œdema. The only piece of evidence advanced in favour of this view is that rabbits on an excessive salt diet become cyanotic; an impartial observer might quite reasonably argue that cyanosis may be the result of the dropsy.

Prof. Fischer argues that disturbances of the circulation cannot be the cause of dropsy because in his dead frogs or strips of gelatin, no circulation was going on at all, and yet they became dropsical. Acidity may be, and probably is, one cause in œdema-production; but this is a very different thing from maintaining that it will explain everything; one might just as well search for a universal pill which will cure all the ills to which human flesh is heir. W. D. H.

The Chemistry of Paints and Painting. By Sir A. Church. Fourth edition. Pp. ix + 387. (London: Seeley, Service and Co., Ltd., 1915.) Price 7s. 6d. net.

The facts that this is a fourth edition, and that the author has been before the world for more than fifty years as a student of the subject on which he writes, are sufficient reasons for welcoming it with respect. But the volume itself fully justifies its existence, and it is difficult, if not impossible, to suggest any change in it that would better fit it to serve the purpose for which it was originally issued. The temptation to use a material that facilitates or immediately improves one's work without due regard to its lasting qualities is always very strong, and especially is this the case with those who are so absorbed in the study and practice of pictorial art, that the scientific aspect of their work becomes distasteful to them. But it is not right to accept ignorantly the opinion of the salesman, however honest he may be, or to trust to a few superficial experiments made by one's self or one's friends. The author deals with painting grounds, vehicles, varnishes, pigments, methods, and results, giving just such details concerning them as the artist wishes, or ought to wish, to know.

The previous edition of the treatise was translated into German and edited by Prof. Ostwald, who added a few paragraphs. The author has incorporated the substance of these in the present edition, definitely indicating such paragraphs, and adding to their value by comments of his own. He gives, in short, the results of probably all those who are known to have systematically tested pigments for permanency, and usefully, and we think fairly, criticises the methods and results of these investigators. The preservation and restoration of pictures receive due attention, and throughout the volume the style of the author is such that a previous acquaintance with scientific principles and nomenclature is not necessary for the understanding of it.

Machine-shop Practice. By W. J. Kaup. Pp. xii + 199. Second edition. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5s. 6d. net.

In this little book will be found descriptions of the hand- and machine-tools employed in an up-to-date workshop, together with clear instructions for their use. The author has desired to lead the pupil in the shop to think, and not merely to do. For this reason the why of each step or operation is emphasised as much as the how. The function of college workshops is to familiarise students with the working properties of the materials employed and with the tools in general use. Such information cannot be adequately obtained from any book, but a book may be very useful for the purpose of supplementing the verbal explanations of the instructor. It is not easy to make other than mental notes in the course of workshop practice, and it is often inconvenient to pull a machine, or part of a machine, to pieces for the purpose of explanation.

The book before us will be found to be very helpful in such matters. Probably the most noteworthy feature in it is the clearness of the illustrations. Where most books of the kind contain merely half-tone illustrations of machines (generally from makers' catalogues), the author has given perspective line drawings, and has named the parts clearly on the drawings. These drawings will be found to be of much value, even when the machine installed in the students' workshop differs in detail from that in the book. Nomenclature is not so serious a barrier in this volume as in some American books. We can heartily commend this book to workshop instructors.

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 Age of the Earth.

While reading through Dr. F. A. Lindemann's defence of Lord Kelvin's estimate of the age of the earth, I was reminded that in spite of the sympathetic spirit in which he always entered into any discussion, he would never allow the least doubt to be thrown on the correctness of his estimate of the earth's age. Yet it is open to several objections: he assumed that the solidified crust, as it was being formed, would sink toward the centre of the earth until it was solid throughout, whereas there can be no doubt about its core being so heavy that the crust material could not possibly sink. He also assumed a diminishing rate of cooling, whereas the greater portion of the earth's surface is covered by water the bottom temperature of which must have been practically constant for millions of years. He also cuts down the temperature in the earth's centre from 410,000° F., which it would be according to his assumption, to 7000° F.; whereby the available heat is reduced enormously. However, if radio-active processes can supply the earth's radiation losses there is no need to deal with the older question.

I notice that Dr. F. A. Lindemann draws the conclusion that the sun's radiation just compensates the amount lost by the earth, but this is not correct. The earth's loss is estimated from the known temperature gradient in the earth's crust; it is a net loss over and above any possible interchange of heat with the sun. Then, also, Dr. Lindemann limits the earth's age by the sun's age, but amongst the several possible sources of its heat supply he does not even mention the heat-producing power of a meteoric bombardment. Yet, as I have shown in my work, "Unity in Nature," in the chapter on matter (pp. 85–92), it is not at all unlikely in comparatively recent time the sun may have passed through a large cloud of heavy meteoric matter. One effect of a comparatively slight addition of heavy meteoric matter would have been to increase its density from, say, 1·00 to 1·38, and the other effect would have been to raise the sun's surface to such a high temperature that it would have evaporated and formed an atmosphere extending perhaps beyond the orbits of the asteroids. In fact, the difference in the densities of the inner and outer planets and the sun, and the fact that practically all rotations and revolutions are in the same sense, suggest that our solar system once consisted of a sun and the outer planets, all having a very low density, and that on passing through a cloud of heavy meteoric matter, the density of the sun was slightly increased, and the inner heavy planets created; but it is impossible here to go into the details of these interesting questions.

As regards the nearer evidence of the earth's age to be sought for in the sedimentary rocks, no notice seems to have been taken either of the time required for the innumerable raisings and lowerings of level which certainly occurred during the coal periods or of the time which it must have taken to tilt horizontal strata through 90° and more. Thus Japan is being tilted at the rate of about 0·5″ per century, and if this tilting rate were steadily maintained in one locality, which is highly improbable, the Japanese strata would stand on end like our Cambrian strata in about forty million years' time. Yet a few such tiltings were completed before some of our oldest strata were formed and overthrusts suggest a still greater antiquity for the age of sedimentary rocks. C. E. Stromeyer.

"Lancefield," West Didsbury, April 26.

Man's True Thermal Environment.

In connection with Prof. Leonard Hill's very interesting and instructive article on "Healthy Atmospheres" (Nature, April 22), perhaps I may be allowed to direct attention to a paper which I contributed to the Journal of the Scottish Meteorological Society for 1912, entitled "On Atmospheric Cooling and its Measurement: An Experimental Investigation." In that paper will be found a description of an instrument termed a psuchrainometer (ψυχραίνω = I become cold; and μέτρον = a measure) which traces on a moving paper strip, a continuous record of the amount of electrical heating needed to maintain at blood heat a body freely exposed to the atmosphere. This seems to serve much the same purpose as Prof. Hill's caleometer. In the same paper I also gave a table of preliminary numerical results obtained by its use in conjunction with an anemometer and self-recording thermometer, and from these data deduced an empirical formula giving the rate of cooling (ψ) as a function of temperature and wind velocity.

The question as to whether ψ could always be thus expressed as a function of already existing meteorological data can only be settled by a long continued series of observations with appropriate instruments, in the construction of which I have been engaged for some time. If ψ can be so expressed, then evidently there would be no need for a widespread installation of special apparatus for its measurements. If, however, this hope be disappointed, a new apparatus must be placed in the hands of meteorologists, and the simpler this is the better. I have now constructed a simple psuchrainometer, consisting essentially of a thermometer furnished with a small heater through which a constant current is always passing. This may be termed a "constant energy" psuchrainometer, and I propose to calibrate it against the necessarily more complicated form of "constant temperature" psuchrainometer, different patterns of which are described both in Prof. Hill's article and in my paper.

James Robert Milne.

Physical Laboratory, Edinburgh University, April 30.

THE AUSTRALIAN ANTARCTIC EXPEDITION.[1]

The most vexed question in antarctic geography has been the nature of the region west of South Victoria Land. D'Urville and Wilkes, who explored that region in 1838 and 1839, reported land in so many localities that it has been generally believed that their tracks skirted a continuous ice-covered and ice-barred land. Ross, however, sailed across the site of some of the land reported by Wilkes, and later explorers have had the same experience. The view has therefore often been held that this part of Antarctica consists of an archipelago. The first material step toward the solution of this problem was the sledge journey of David, Mawson, and Mackay during Shackleton's expedition. Their journey afforded strong evidence in favour of the continuity of the land; but this land might end far south of Wilkes's track and be separated from it by a fringe of islands. This question has been finally settled by the Australian expedition of 1911 to 1914 under Sir Douglas Mawson. The narrative of its experiences with some indications of its scientific results are given in two massive and superbly illustrated volumes.

The expedition sailed in the *Aurora* under the skilful command of Capt. Davis, whose soundings between Australia and the opposite coast of Antarctica are themselves of the highest geographical importance. Two bases were established in Antarctica, the main base in Adelie Land (about 142°40′ E.), and a western base under Wild in Queen Mary Land (95° E.); at each of these stations elaborate observations were taken, and the expedition established on Macquarrie Island a wireless station, which should be permanently maintained in the interests of Australian meteorology. From each of the bases extensive sledging expeditions were made to explore the surrounding areas. Wild sledged 4° eastward along the northern coast to Queen Mary Land in the hope of reaching Knox Land. A second party under Dr. S. E. Jones travelled westward to the Gaussberg, and thus reached the field of work of the German Antarctic Expedition under Drygalski. From the main base in Adelie Land one sledging party went eastward to Deakin Bay; a second under Bage nearly reached the Magnetic Pole; a western party sledged 4½° along the coast which had been seen by D'Urville. A sledge journey eastward over the ice-covered plateau led to one of the most tragic of Antarctic adventures, for Mertz and Ninnis perished on the journey, and only the lucky finding of a food depôt enabled Mawson to crawl back to his base.

The journey toward the South Magnetic Pole under Dr. Bage was one of the most arduous and successful of the sledging expeditions. The party reached lat. 70°36′5″ S. and 148°10′ E., where the magnet had a dip of 89°43½′ or only 16½

[1] "The Home of the Blizzard. Being the Story of the Australasian Antarctic Expedition, 1911–14." By Sir Douglas Mawson. Vol. i. Pp. xxx+349. Vol. ii. Pp. xiii+338. (London: W. Heinemann, 1915.) Price 36*s.* net two volumes.

min. from the vertical. This locality was 175 miles from the point reached by David's party in 1909, so the two journeys gave a nearly full section across Antarctica from South Victoria Land to Wilkes Land.

These great sledge journeys, combined with Capt. Davis's soundings along the coast, have proved the existence of land all along this part of Antarctica, though somewhat south of the positions where it was reported by Wilkes. Thus the *Aurora* sailed in clear weather over the site of the land marked by Wilkes to the east of his Cape Carr. Nevertheless, the result of the expedition is to confirm the general belief that from Cape Adare, for more than 80° westward, is one continuous ice-capped land, which forms the northern coast of Antarctica. Mawson attaches the name of the American explorer to a small part of this area, but the name of Wilkes Land appears too firmly established for the whole of it to be easily displaced. The discovery by the expedition of Queen Mary Land in the west, the long line of land to the west of Adelie Land, and of King George V. Land on the east has definitely established the northern coast of Antarctica in this district as approximately along the line of the antarctic circle. There are indications, however, from the charts that either shallow water or land extends in some places north of the circle.

FIG. 1.—The *Aurora* lying at anchor, Commonwealth Bay. In the distance the ice slopes of the mainland are visible rising to a height of 2000 feet. In the foreground is a striking formation originating by the freezing of spray dashed up by the hurricane wind. From Sir Douglas Mawson's "The Home of the Blizzard." (W. Heinemann.)

The greatest trial of the expedition was the terrific violence of the wind. Gusts of wind are recorded with a velocity of two hundred miles per hour. The rate of 180 miles per hour is said (vol. i., p. 168) to have been common. The average velocities recorded for whole days are unprecedented. Thus on May 15 the mean for the whole twenty-four hours is given as ninety miles per hour. On May 18, a year later, it was 93·7 miles. The average for May was 60·7 miles per hour. The most appalling testimony to the wind strength is the record that the average speed for the whole year was fifty miles per hour (vol. ii., p. 157). Both volumes contain repeated references to hardships due to these hurricanes, and the prevalence of winds blowing at 100 miles per hour with a temperature of −28° F. (vol. i., p. 134) justifies Sir Douglas Mawson's lament that owing to "the rushing might of these eternal blizzards" Wilkes Land is "an accursed country" (p. 134). The wind records were apparently mainly made by a Robinson anemometer, which we are told was the greatest source of worry; and as meteorological authorities have issued frequent warnings of the untrustworthiness of anemometers, opinion as to the exact value of the records may be suspended until more detailed accounts of the observations are issued. There is, however, abundant evidence in the book to show that the main base is abnormally windy, and perhaps to justify the claim that it is the windiest place on earth. The "Roaring 'Forties" must give place to the "Shrieking 'Sixties." The author explains the power of the wind as due to the torrent of air rushing outward from a high pressure area around the south pole; but it is difficult to reconcile this theory, as now stated, with the experiences of Amundsen and Shackleton.

Fig. 2.—A view of a rocky stretch of the Adelie land coast west of Commonwealth Bay. From Sir Douglas Mawson's "The Home of the Blizzard." (W. Heinemann.)

The book, like much Antarctic literature, must have its usefulness restricted by its bulk; private students can scarcely afford the book space for such cumbrous volumes, a fact the more regrettable in this case owing to the exceptional beauty of the illustrations. Colour photography has been used with excellent results, and those of the starfish show the great value of this process in biology. The work includes only preliminary notices of the scientific results, but it shows that the Australian Expedition must rank as one of the most successful of modern antarctic expeditions.

J. W. G.

RECORDING RAIN GAUGES.

Of mechanical devices for the registration of rainfall there is no end, and from the early date of most of them it is scarcely too much to say that in this direction there is no new thing under the sun. Up to 1898 Mr. G. J. Symons had described and figured in "British Rainfall" no fewer than forty-five different patterns of self-recording rain gauges, and now there are at least a dozen more. Very few of these have proved fully satisfactory. The diversity between the various forms consists mainly in subordinate details. With the exception of Mr. W. J. E. Binnie's electrical drop-counter and Wild-Hasler's over-shot water wheel, I cannot find more than three principles which have been applied singly or in combination for the automatic recording of rainfall by a pen writing on a rotating drum. These are (1) the double tipping-bucket on a fixed pivot; (2) the descending counterpoised receiver, and (3) the ascending float.

Tipping-bucket rain gauges are amongst the oldest forms, and they have been constructed to record directly or through an electrical device, by an escapement wheel, a cam in the axle of which raises the pen by a step at a time, the value of the interval shown by the step being the capacity of the bucket, which empties as it tips. The best instrument of this type is that in use by the United States Weather Bureau, which has a bucket tipping with one-thousandth of an inch of rain, and so gives a fairly continuous line, even in moderately light showers. Attractive and well-made tipping-bucket rain gauges have been put on the market by the firms of Negretti and Zambra, and Pastorelli and Rapkin, of London, and by Richard Frères in Paris. These tip with one-hundredth of an inch, or sometimes with half that amount, but are useless for measuring duration of any but heavy rain, though under careful inspection fairly satisfactory for measuring amounts. The amount of rain can always be measured more accurately by means of a direct reading rain gauge of the Snowdon or Meteorological Office pattern, of which the former is, in my opinion, better as well as cheaper.

The only scientific purpose served by a recording rain gauge is to furnish a measure of duration and intensity. The two types of gauge involving the respective use of a counterpoised receiver or of a float give their record in the form of a continuous curve. Each type has several modifications rendered necessary by the practical convenience of using a shallow drum while retaining an open scale. Where expense and space are no objects rain gauges of unimpeachable accuracy can be made on either principle by having a drum deep enough to record the whole rainfall of the wettest day possible with the necessary degree of magnification.

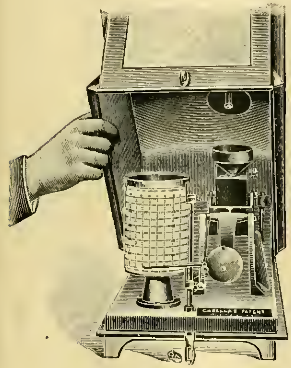

FIG. 1.—New Casella recording rain-gauge.

In order to keep the moving parts compact and the drum small, the capacity of the receiver is in practice usually limited to from 0·20 in. in the case of a counterpoised vessel to 0·50 in., or rarely 1 in., in the case of a float, and an automatic contrivance for emptying the vessel whenever it fills has to be employed. This is the weak point of most recording rain gauges, for when the receiver has to be emptied five times for every inch of rain it is subject to much friction and wear, and when it empties only once or twice for an inch of rain the time of clearing is appreciable and introduces a risk of error.

The Beckley rain gauge made by Mr. Hicks and used in the observatories of the Meteorological Office for about forty years is the best example of a counterpoised receiver writing directly on the drum as it sinks vertically and discharging automatically by means of a self-starting syphon. The Casella recording gauge, which has been in use at Camden Square for about thirty-five years, is undoubtedly the best example of the counterpoised receiver emptying by automatic tipping when it comes to the lowest point. It writes by means of a system of levers on a drum with a horizontal axis. A modified form of this gauge (Fig. 1), recently introduced by Messrs. Casella at a low price, has a simpler mechanism, the receiver only tipping far enough to start a syphon, through which it is emptied, while the pen writes on a vertical drum by means of a hinged piece at right-angles to the main lever, thus securing a curve with approximately rectangular co-ordinates.

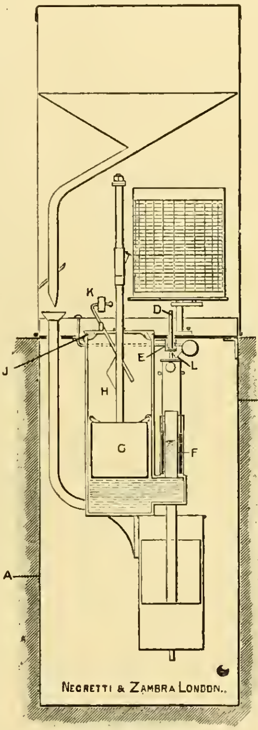

FIG. 2.—Section of Halliwell standard recording rain-gauge.

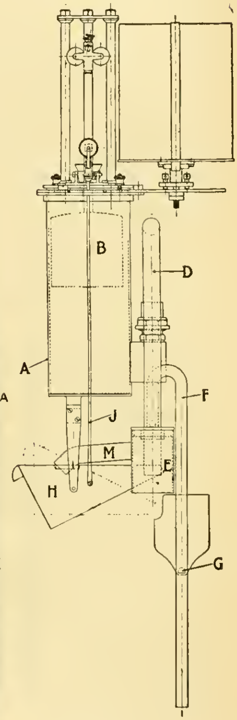

FIG. 3.—Mechanism of the Fernley recording rain-gauge.

Of float rain gauges the best of which I have had experience is the improved form of the Halliwell rain gauge (Fig. 2) first constructed by Mr. F. L. Halliwell with the advice of Mr. Baxendell, the well-known director of the Fernley Observatory, Southport, and now manufactured by Negretti and Zambra. The theory is to make use of a pen actuated directly by a rod rising with the float (G), the receiver emptying by means of a syphon of large bore (F) started by being dropped a little by the action of a trigger (K) set off by the float rod when the receiver is full, and reset automatically by the escaping water entering a lower cylinder. In its first form this instrument was troublesome, sometimes failing to discharge, sometimes discharging too soon, but these difficulties have now been overcome, and when it is in careful hands I know of no better recording gauge. It gives an exceedingly clear and steady trace, and is much more sensitive to light rain than the Standard Casella gauge, while its less frequent discharges and rapid emptying give great accuracy in the case of heavy falls. The main drawback is the employment of mercury in connection with the syphon.

The Fernley recording gauge (Fig. 3), also constructed by Messrs. Negretti and Zambra, is the most recent product of Mr. Baxendell's ingenuity, and I have had it under observation along with the Casella and Halliwell gauges at Camden Square for six months. The record it produces is as clear and sensitive as that of the Halliwell gauge, from which it differs only in the simpler method of starting the large-bore syphon, avoiding the use of mercury. This is accomplished by the interposition of a small tipping bucket (H) filled with water. The bucket is tipped by a trigger actuated as in the Halliwell gauge, and discharges into the lower part (E) of the long leg of the syphon, which is started by the water pump action thus set up. The mechanism is certainly simpler than that of the Halliwell gauge, and the action is perhaps more certain than that of the first form of Halliwell. The principle is sound, and was employed in Osler's famous recording gauge of 1837.

The difficulty presented by all accurate recording instruments of different types is to ensure comparability, so that regional variations in duration and intensity may be worked out. To insist on the use of one make of instrument would hamper progress and discourage that competition between inventors and instrument makers on which so much depends for the progressive improvement of practical details. As the result of many years' experience I have formulated the requirements of a satisfactory recording rain gauge for general use, as follows:—

(1) A recording rain gauge is not a labour-saving contrivance which will work by itself for a week or more. The time scale should be so open that a drum of reasonable size cannot include more than the record of twenty-four hours, and it must be visited daily and the pen set to the correct time every morning.

(2) If a recording rain gauge is to be generally adopted its price must be less than 10*l.*, substantially so if possible, hence great size and elaborate mechanism must be avoided.

(3) The depth scale must be magnified at least four, and preferably eight times, and to avoid the inconvenience of having a very high drum some mechanical arrangement must be made by which the pen, on reaching the end of the chart, returns to zero automatically.

(4) The usual method of bringing the pen back to zero by emptying the receiver when half an inch or less of rain has been accumulated necessitates the use of uncertain or complicated mechanism, hence the receiver should be large enough to contain at least four inches of rain, and the automatic return of the pen should be secured by some device unconnected with the discharge.

(5) Friction is the only other serious practical difficulty, and this should be minimised by having as few moving parts as possible and these with the shortest bearings compatible with rigidity.

It was in order to meet these views that Messrs. Casella introduced their modification of their old standard recording gauge, but though most of the conditions were complied with, No. 4 was not. The Hyetograph (Fig. 4) devised at the same time by Negretti and Zambra, carries out my views more nearly than any other gauge I know; but it has not quite overcome the difficulty of friction in the float chamber, though when signs of this appear a very slight adjustment puts things right. Its curve also presents the inconvenience common to those of the ordinary barograph and thermograph of being referable to a straight co-ordinate for time and to the arc of a circle for amount.

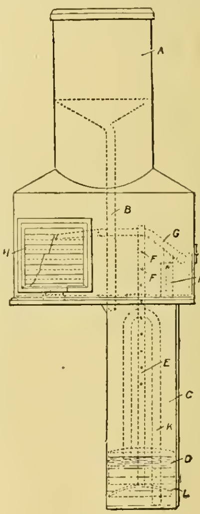

Fig. 4.—Section of Hyetograph.

Its advantages are that the receiver takes four inches of rain without overflowing, an amount which, it is true, may be exceeded in twenty-four hours in any part of the country, but which cannot be expected to be exceeded twice in a lifetime at the same place. It is emptied by a syphon actuated by suddenly depressing the float by hand, and should be so emptied each morning when the amount collected exceeds a small fraction of an inch. The pen drops on reaching the top of the chart by the edge of a plate fixed on the pen lever dropping from a peg (F) on the float rod (E) on to another peg below, an oil brake (M) at the short end of the lever (G) absorbing the shock. The record is thus not interrupted so long as rain is falling. During snow, a night-light placed in the instrument under the funnel ensures instantaneous melting.

I may perhaps be allowed to mention that neither the British Rainfall Organisation nor I personally have any financial interest in any rain-measuring appliances, and we thus retain perfect freedom for the helpful criticism of all such instruments.

HUGH ROBERT MILL.

INSECT PESTS AND WAR.[1]

WAR is associated in the popular mind with the summoning of armies, the thunder of the guns, and the carnage of blood-stained battlefields. Patriotism is manifested in personal sacrifice in many directions, some public, many unsuspected. All cannot help in the direct attack on our enemies, but all are able to assist in preventing disease that plays so important a part in the progress of a campaign. Horrible as are the features of any war, times arise when the destructive "minor horrors," or insect pests, that are the inevitable accompaniment of the concentration of large numbers of men, assume a major import. The victims of the typhus now ravaging Serbia know this only too well. It is, then, a patriotic action on the part of Dr. Shipley to have set forth the life-histories of many noxious and disease-carrying arthropods, as well as certain leeches, together with very practical hints as to their prevention, in his book, "The Minor Horrors of War."

At the present time there is an undoubted need for the dissemination of knowledge regarding the *rôle* of various pests, both insect and others, in a simple yet practical form. The advantage is considerably increased when the information is presented in a lucid manner, with numerous illustrations, and in a style that may perhaps be best described as fully human. The accounts of the habits of lice, bugs, fleas, flies, mites, ticks, and leeches, which all have a share in injuring man, are set forth in a form that arrests the attention, stimulates personal interest, and, at the same time, by humorous interludes, neither repels nor disgusts the reader. The practical side, as before mentioned, is kept in view throughout.

Lice undoubtedly are unpleasant, but to ignore their existence does not minimise the danger arising from their presence. At least two diseases that are known to occur in certain areas of the present war zone are transmitted by lice (Fig. 1). Relapsing fever is due to a spirochæte that develops in the body-louse. The spirochæte reaches man when, in his endeavour to alleviate the irritation due to the insect, he scratches his skin. Simultaneously, he crushes one or more of the unwelcome insects, and spirochætes are unwittingly rubbed into the slightly damaged skin. Troops operating in Africa understand how easy it is to touch the eyes to remove sand or dust, and a finger soiled by a crushed louse has been shown to convey relapsing fever when so used. Typhus fever also is spread by lice, and there is no need to dwell on the fearful rapidity with which this fell disease may spread.

It must be remembered that the irritation of the body due to insect pests reacts on the mind, and is manifested in mental restlessness and lowered spirits. The clearly expressed preventive measures recommended against lice will doubtless be appreciated during the present campaign.

Bugs are very undesirable intruders in houses, and troops operating in India and Persia have reason to fear their attentions. Ticks occur in the Eastern theatre of war, and also in African territory where other troops are engaged. One tick, *Ornithodorus moubata,* transmits *Spirochaeta duttoni,* the cause of a more severe form of relapsing fever. The young tick is unlike the adult, and being so much smaller, is more easily overlooked, and is therefore more dangerous, especially as it may be born infected. Knowledge of its life-history, as set forth by Dr. Shipley, is important.

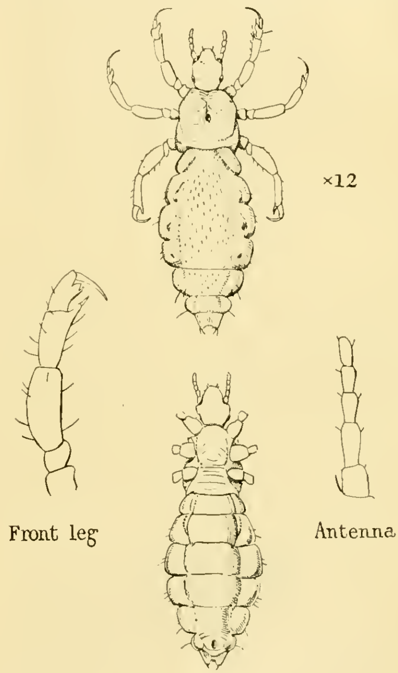

FIG. 1.—*Pediculus vestimenti.* The louse. Dorsal and ventral views. From "The Minor Horrors of War."

Mites are small relatives of ticks, and those that infest man are often known to soldiers and field-workers by the name of harvest mites. The habits of these small pests, as well as those of the "itch insect," together with the modes of dislodging them, are facts that should be better

[1] "The Minor Horrors of War." By Dr. A. E. Shipley. Pp. xvii+166. (London: Smith, Elder and Co., 1915.) Price 1*s.* 6*d.* net in paper covers, 2*s.* net in cloth.

known. Fleas, too, need attention. The dreaded plague is spread by means of infected rat-fleas that leave their natural host and pass to man. Fleas also convey other diseases, and apart from this, the broken rest due to flea-bites is a factor that makes even such an insignificant insect worthy of consideration.

Blood-sucking leeches occur in Belgium and Germany, and also in parts of India, Ceylon, Egypt, and Palestine. These animals, although not belonging to the arthropoda, constitute a

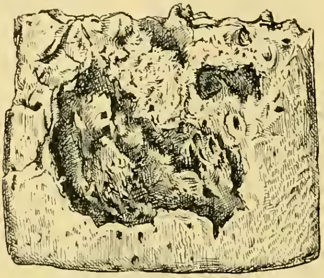

Fig. 2.—*Ephestia kühniella*. Moth-infested biscuit. From "The Minor Horrors of War."

very real pest in some places, as they may occur in drinking water. The straining or filtering of drinking water and boiling it before use are simple means of avoiding distressing throat and lung troubles. The existence of voracious Indian land leeches, lurking among foliage in wait for their prey, will probably be news to many, but provides a useful hint with regard to sites for camping.

Man is affected by insect parasites not only through direct attacks upon himself, but also by infestation of his dwellings and his food. Flies

Fig. 3.—*Musca domestica*, the house-fly, in the act of regurgitating food. ×4½ (After Gordon Hewitt.) From "The Minor Horrors of War."

and flour moths are therefore discussed. Fortunately, the occurrence of "maggotty" biscuit (Fig. 2) is not so common as formerly, but the possibility of its recurrence under war conditions should be remembered. Flies are a more serious pest. House-flies are concerned with the conveyance of several diseases to man, typhoid fever perhaps being the best known. The typhoid bacilli can live for six days in the intestine of a house-fly, and food and milk can be polluted by its promiscuous visits during this period (Fig. 3). Insight into the life-history and habits of flies is sufficient to cause anyone to join in the anti-fly crusade. The love of filth and carrion displayed by the various blow-flies or meat-flies, too, is a means of spreading disease, and there are records, even in the present war, of wounded men suffering agony from the presence of fly larvæ in their neglected wounds. The abolition of filth is the simplest means of securing freedom from flies by destroying their breeding places.

The relation of insect pests to the health of men and animals is a subject of interest to all, and it is not surprising that the large first edition of Dr. Shipley's book was practically exhausted in a month, and that a second edition is in preparation. The combination of literary charm and scientific information of practical utility, particularly at the present time, is certain to ensure its continued success. H. B. Fantham.

THE SUPPLY OF OPTICAL GLASS.

THE serious position in which this country was placed at the outbreak of hostilities by the almost complete stoppage of the supply of optical glass and of the import of optical instruments, is at last attracting the attention of the public which should have been much sooner focussed upon it. The importance of the subject was early recognised by the British Science Guild, which referred its consideration to its Technical Optics Committee. This committee, after fully investigating the evidence then available, reported, and the guild forwarded an important report to the Board of Trade; the report was printed in full in our issue of March 25 (page 104). So far as can be ascertained, however, no official action appears to have resulted.

Quite recently, Sir Philip Magnus, the member for the University of London, put on the order paper of the House of Commons questions addressed to the representatives of the War Office and the Admiralty, asking whether the supply of optical glass and optical instruments for the use of the Services was keeping pace with their immediate requirements. To these questions official replies of the stereotyped order were given and, in addition, the representative of the Admiralty informed the House that a large firm of makers of optical glass in this country "had greatly increased their output and were still adding to their plant." Before these replies were given, a long letter on the subject was published in the *Times* over the signature of Dr. Walmsley, the Principal of the Northampton Polytechnic Institute, an institute which is intimately associated with technical instruction in applied optics. There had also been other allusions to the matter in the Press.

In the report of the British Science Guild, referred to above, the main points involved are clearly indicated; and with regard to the supply of optical glass for instruments required by the Government, the report states that at the time of its issue there seemed to be no call for any special effort. This statement, however, was made in January, and things have not been standing still since. More especially there was no indication then that either the country or the Government was aware of the necessity for enormous efforts for the adequate supply of "munitions," amongst which must be included "optical appliances." As is well known, the only firm supplying optical glass in this country is the firm referred to in the House of Commons, namely, Messrs. Chance Brothers, of Birmingham; and a paragraph appeared in the *Times* on April 26 to the effect that this firm will now supply optical glass only to those manufacturers of optical instruments who can produce a War Office or Admiralty certificate showing that the glass is needed for the fulfilment of a Government contract. This means that, notwithstanding the large increase in the capacity of the plant at Birmingham, the whole of the optical industry of this country, other than that engaged in Government work, cannot be supplied at the present time with any optical glass whatever. When we consider the important trades which require such glass in fairly large quantities for other than Government purposes, there is no doubt of the great seriousness of the position. But so optimistic is the Government that it has declined a patriotic offer of Lieut.-Col. J. W. Gifford to hand over to the nation free of cost practically the whole of a collection of fine optical glass, considerably over a ton in weight, which he has accumulated during twelve years of laborious research, some of the results of which have been published by the Royal Society from time to time.

The definite proposal made in Dr. Walmsley's letter to the *Times* is that the Government should at once take over the optical glass branch of Messrs. Chance's factory. We understand that this proposal is, as yet, a suggestion of Dr. Walmsley's only, and that, for obvious reasons, he did not communicate beforehand with the firm in question. In passing, we may say that great credit is due to this firm for its very vigorous and patriotic efforts to deal with the situation, but the matter appears to us to have got beyond the point at which any private firm should be required, for the good of the whole community, to undertake such heavy capital expenditure as it has already made and to risk the great sacrifices which may be called for if this expenditure be rendered unproductive after the war. As pointed out by Dr. Walmsley, the natural solution, that competing firms should instal plant and enter the market, is not applicable in this case, because the whole amount involved is too small to make it worth while for any important firm to enter into competition. The supply of fine optical glass for the United Kingdom involves probably an outside turn-over of not more than 20,000*l.* a year, an amount which is not worth dividing. But the supply of this small quantity of raw material, in the form of unwrought optical glass, affects an industry in which the value of the finished products runs to millions of pounds' worth of goods per annum, and in which the greater part of the cost of output goes in wages to highly skilled labour.

It is true that the firm named already has risen to the occasion, has octupled its plant, and, if Ministerial replies are taken at their full face value, has succeeded so far as to supply present Government requirements. But what of the rest of the industry, and, moreover, what is to happen when the war is over? The foreign supply of this vital "key" product will doubtless be resumed, surrounded by the *ante bellum* "wire entanglements" to which Dr. Walmsley refers, such as restrictive contracts on users, the lodging of dummy and blocking patents in our Patent Office, and all those means by which officially-nurtured foreign competition in the past has endeavoured to kill the production in this country of the far more vital and more costly finished products. Is it too late in the day to ask that these methods of competition should not be used against private firms without any greater safeguards available than those which have proved so ineffective in the past?

It seems to us that the proper course is to act generally in the direction of Dr. Walmsley's suggestion, with such modifications as may be found desirable on full investigation. This would mean, in substance, that the Government should undertake the supply of this "key" product. With a Government department empowered to deal with eventualities, full attention could be given to the other important matters dealt with in the report of the British Science Guild, namely, the adequate development of research, better provision for the testing of the physical and optical properties of samples of glass, and, most important of all, provision for adequate technical training and research in applied optics, so that this country may recapture speedily the position it held for so long in the forefront of the world's optical developments.

ASPHYXIATING GASES IN WARFARE.

DR. J. S. HALDANE'S report on his investigation of the nature and effects of the asphyxiating gases, used by the Germans in their attack last week on the French and British lines near Ypres, leaves but little doubt that chlorine or bromine was the chief agent employed, whilst shells containing other irritant poisons were also used.

Prof. H. B. Baker, who accompanied Dr. Haldane, is carrying out an investigation as to the chemical side of the question, and until his report is available, surmises as to the nature of the poisonous gases and the methods adopted for their use would be premature, but the evidence seems to point clearly to the fumes floated by the wind on to the Allies' lines being chlorine, as at ordinary pressure bromine is a liquid below 59° C., and at ordinary temperatures would not give off its vapour with sufficient rapidity to cause the seven-foot bank of vapour that drifted on to the Allies' trenches, whilst the colour of the cloud would have been a rich brown and not the "greenish" or "yellowish-green" colour so frequently described, which undoubtedly points to chlorine.

Chlorine gas is 2·45 times heavier than air, and if discharged "down wind" would only slowly rise, so that at a distance of one hundred yards from its point of disengagement the bank of fume might be expected to be six or seven feet deep, but with bromine vapour, which is more than five times the weight of air, the thickness of the layer of vapour would, under the same conditions, be much less. Liquid chlorine has, for many years, been a commercial article: the gas is liquefied by a pressure of six atmospheres at 0° C., and is stored in lead-lined steel cylinders, being largely exported for use in the extraction of gold in localities where, from difficulties of transport, plant and materials for making the gas *in situ* would be more expensive.

It is said that such cylinders, 4 ft. 6 in. long, were sunk in the German trenches and were connected to pipes six feet long pointing towards the Allies' lines: under these conditions, intense cold would be produced at the point where the cylinders discharged into the delivery pipes by gasification of the liquid and expansion; this would soon check the rapid production of gas, and the white smoke seen behind the greenish cloud of gas may well have been caused by brushwood fires lighted above the delivery pipes to warm them and prevent stoppage.

Although all the evidence and the symptoms found in the unfortunate victims overcome at this particular section of the line point to chlorine as the gas employed, there seems every probability that liquid bromine has also been used in shells or grenades, which, bursting in the air, would scatter the liquid under conditions that would rapidly gasify it, when the weight of the vapour would cause it to descend on the troops below.

Both chlorine gas and bromine vapour, when present to the extent of 5 per cent. in air, rapidly cause death by suffocation, by acting on the mucous linings of the nose, throat, and lungs, so causing acute inflammation; but bromine poisoning is generally distinguishable by the skin of the victim being stained yellow, and the intense action on the eyes, which is much greater than with chlorine.

The Germans have an unfailing source of bromine in the crude carnallite, worked at Stassfurt for the production of potassium chloride, but when full particulars are available it will probably be found that, besides such obvious asphyxiants as chlorine, bromine, and sulphur dioxide, they have also employed compounds of a more complex character.

CHEMICAL STANDARDS FOR WHISKY.

It may be remembered that the Royal Commission on Whisky, which in 1908–9 gave a lengthy consideration to the matter, did not find a very satisfactory answer to the query "What is whisky?" The Government of Western Australia has also been debating this question, and some years ago it issued regulations under which certain chemical standards for "pure pot-still whisky" were proposed for adoption. The proposals met with some criticism. It was alleged, in fact, that many pot-stills employed in Great Britain could not produce whisky which would comply with the requirements.

In order to investigate the matter further the Government analyst for Western Australia was deputed last summer to visit this country. Here, conjointly with an analyst representing the distillers, he inspected some forty Scotch distilleries and analysed a large number of samples of the whisky produced. In addition, twelve distilleries in Ireland were visited alone by the official analyst. The papers now issued[1] give an account of the investigation. They are prefaced by the statement that the proposals, as now modified, have been approved by the Governor in Executive Council and gazetted accordingly.

Briefly, the stipulations are that, as regards Scotch whisky, it shall have been distilled at a strength not more than 35 degrees above proof and matured in wood for not less than two years; and that "standard pot-still whisky" shall contain at least 45 grams of esters, 3·5 of furfural, and 180 of higher alcohols per 100 litres of absolute alcohol, as estimated by methods prescribed. For Irish whisky no furfural standard is proposed at present, but the proportion of esters is required to be not less than 35 grams, and of higher alcohols 200 grams, per 100 litres of absolute alcohol.

Whisky other than "standard pot-still," whether Scotch or Irish, is required to be sold as "blended" whisky. Of this there are three classes, containing respectively at least 75 per cent., at least 50 per cent., and less than 50 per cent. of standard pot-still whisky. For the first and second classes minimum limits are fixed for the proportions of esters, furfural, and higher alcohols—omitting the furfural, however, in the case of Irish whiskies. The third class includes all whisky which does not comply with the requirements for any of the other classes. The respective kinds are to be labelled with the appropriate designations.

A good deal of the criticism to which the original proposals were subjected has been turned aside by the change of a single word in the regulations. "Pure" has become "standard" pot-still whisky. There was just cause of complaint when specifications for the "pure" pot-still product were drawn up, because in certain cases these requirements could not be satisfied by whisky distilled in an apparatus which had certainly hitherto been regarded as a "pot"-still, even if somewhat modified from the simple form. To stigmatise by inference such products as adulterated because they did not comply with the stipulations for "pure" pot-still whisky was indefensible. But, obviously, a community has the right to say what it will regard as a "standard" whisky, and this has now been done.

[1] "Papers in Connection with the Establishment of Standards for Whisky in Western Australia." (Perth: The Government Printer.)

The effect of the regulations will be that as regards the amount of the chief "secondary" constituents (esters, furfural, and higher alcohols), which distinguish whisky from "silent" or patent still spirit, the whisky sold in Western Australia will be classified into four varieties, and the consumer will know, within limits, what is the proportion of these secondary products in the beverage he drinks. C. S.

NOTES.

WE regret to see the announcement of the death on May 4, at seventy years of age, of Sir William R. Gowers, F.R.S., distinguished by his work on diseases of the nervous system and related subjects of medical science.

PROF. SYDNEY J. HICKSON has been elected president of the Manchester Literary and Philosophical Society for the ensuing year (1915–16).

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1914–15:—The Telford gold medal to Mr. A. L. Bell (Rosyth); Telford premiums to Mr. C. W. Anderson (Chakradharpur, India), Sir Thomas Mason (Glasgow), Dr. H. F. Parshall (London), and Mr. H. E. Yerbury (Sheffield), and the Crampton prize to Mr. F. D. Evans (Kuala Lumpur, F.M.S.).

IN reply to a question asked in the House of Commons on May 4, Mr. Tennant said:—"The latest information with regard to the incidence of enteric fever among the British troops in the Expeditionary Force is as follows:—Up to date 963 cases have occurred, and of these 780 have been analysed; 142 cases have occurred in men inoculated fully with two doses of vaccine. Among these ten deaths have occurred, giving a case mortality of 7 per cent.; 157 cases have occurred in men partially protected by inoculation—that is, who have had only one dose of vaccine. Among these there have been ten deaths, giving a case mortality of 6·36 per cent.; 481 cases have occurred in non-inoculated men. Among these there have been 100 deaths, giving a case mortality of 20·79 per cent. To appreciate the full value of these figures it must be brought to notice that 90 per cent. of the troops forming the Expeditionary Force have been inoculated voluntarily. Therefore, among 90 per cent. of the force (*i.e.* inoculated men) there have been 299 cases and twenty deaths. In the other 10 per cent. (uninoculated men) there have been 481 cases and 100 deaths.

ON May 1, at about 5 a.m., the instruments of the seismological observatories of this country registered an earthquake of quite unusual strength, of which, however, we have as yet received no other news. At West Bromwich, the oscillation was so great that one of the recording needles was dismounted. The approximate position of the epicentre, as deduced from the Eskdalemuir seismogram, is latitude 47° N., longitude 156° E., or on the east side of the Kurile Islands. The earthquake is evidently one of the most interesting of the last decade. The Kurile Islands and the Japanese Empire are, as is well known, in the form of festoons, the convex, or eastern side, of which slopes steeply into the deeper waters of the Pacific Ocean. In the Kurile Islands, earthquakes are weak and infrequent as compared with Japan. The recent earthquake thus visited a district in which great shocks are almost or quite unknown. Moreover, the epicentre lies (at a depth of about 4000 fathoms) near the base of the western slope of the great depression which forms the north-easterly continuation of the Tuscarora Deeps.

IN view of the Chancellor of the Exchequer's proposals for a differential tax on beer, it may be of interest to note in what manner the specific gravity of beer is related to its alcoholic strength. As explained in an article in NATURE of April 8, the basis of the beer duty is not the actual amount of alcohol in the beer, but its potential amount as measured by the "original" specific gravity of the wort. In beer as it is sold, the proportion of alcohol varies somewhat even for worts of the same original specific gravity, because they may be fermented to somewhat different degrees either in the primary fermentation or in the slow after-fermentation which generally supervenes. Broadly, however, it may be said that in light beer of original gravity 1043 (water = 1000), the tax on which is not affected by the present proposals, the proportion of alcohol is usually about 6 or 7 per cent. of proof spirit. This represents $3\frac{1}{2}$ to 4 per cent. of real alcohol—that is, of ethyl hydroxide, $C_2H_5.OH$, by volume. Beer of original specific gravity 1050 to 1055, on which a supertax is to be levied, contains about 9 to 11 per cent. of proof spirit when sold, corresponding with $5\frac{1}{4}$ to $6\frac{1}{4}$ per cent. of real alcohol. This represents the beer ordinarily drunk, such as dinner ale, pale ale, "porter," and the beer generally supplied on draught in public-houses. Heavier beers and stout range from about 1060° to 1090° of original gravity; these contain from 11 to 14 per cent. of proof spirit, or $6\frac{1}{4}$ to 8 per cent. of real alcohol. In special "strong ale" the original gravity may be more than 1100°, and the amount of proof spirit as much as 20 per cent., or approximately $11\frac{1}{2}$ per cent. of alcohol.

WE have sadly to record the death of Erasmus Darwin, the only son of Mr. and Mrs. Horace Darwin, of Cambridge, and a grandson of Charles Darwin, and of the first Lord Farrer. He was killed on April 24, leading his men in action in Flanders. On the outbreak of war in August last he instantly applied for a commission, and was gazetted Second Lieutenant in the 4th Battalion Alexandra Princess of Wales's Own Yorkshire Regiment in September last. He went into camp at Darlington until November, and then was stationed at Newcastle-on-Tyne, and was put in command of the scout work, which he entered into with all that quiet zest which was characteristic of him. He delighted in the work of training himself and his men in long expeditions by night and by day over the moors. Not even the pressing offer, which was made to him a few days before he went to the front, of an important post at home in connection with munitions of war would move him from his desire to give his personal services at the front with the scouts to whom he had become so attached. He was a man of very lovable disposition and unusual ability. He was born on December 7, 1881, and was educated at Marlborough and Trinity College, Cambridge. He took the Mathematical Tripos in his second year, 1903, and afterwards passed out in the Mechanical Sciences Tripos in 1905. For some time after taking his degree he worked at Messrs. Mather and Platt's at Manchester. For a time, too, he carried out important work in the test-room of the Cambridge Scientific Instrument Company, and by his exceptional business ability and foresight he rendered highly valued service as a director of the company. About seven years ago he went to Messrs. Bolckow Vaughan's at Middlesbrough, and his sound practical judgment and administrative ability soon won for him a very important position in the firm. In this war the country has to mourn the loss of many valuable lives, and Erasmus Darwin was one of those whose fine, modest conscientiousness and unswerving strength and loyalty made us know that we lose a man whom we should have been proud to see taking his part in the guiding of public affairs in the country.

THE director of the Meteorological Office, Dr. W. N. Shaw, has sent us a copy of a new scale of velocity equivalents of the numbers of the Beaufort scale of wind force which he has received from Prince Boris Galitzin, the director of the Russian Meteorological Service. The table has been drawn up at the Observatoire Physique Central Nicolas, and expresses the wind force determined by the Wild wind-gauge in terms of the Beaufort scale. These values will be used by Russian Meteorological stations as from May 1. The table has been compiled in accordance with the decisions of the International Meteorological Committee, at the meeting held at Rome in 1913.

Beaufort scale	Velocity in metres per second	Beaufort scale	Velocity in metres per second
0	0	7	14–17
1	1	8	18–20
2	2–3	9	21–24
3	4–5	10	25–28
4	6–8	11	29–33
5	9–10	12	34 and more.
6	11–13		

THE Smithsonian Institution announces that fossil bacteria have been discovered in very ancient limestones collected in Gallatin County, Montana, by Dr. C. D. Walcott, secretary of the institution. For some time Dr. Walcott has believed that these bacteria existed, and mention of the fact was made before the Botanical Society of Washington on April 6, when attention was directed to their existence in association with fossil algal deposits of the Newland limestone. The belief that bacteria were the most important factor in the deposition of these ancient limestones was also mentioned by Dr. Walcott in a preliminary publication of the Smithsonian Institution. At that time, however, no definite bacteria had been discovered, but in thin sections of limestone from the collections made in 1914 the microscope now shows these very minute forms of life, some twenty to thirty million of years old. The bacteria were discovered in three sections cut from an algal form included under the generic name Gallatinia, named after the great American explorer Gallatin. The bacteria consist of individual cells and apparent chains of cells which correspond in their physical appearance with the cells of Micrococci.

THE Art Museum of Boston has recently acquired one of the gems of Minoan art, which is described by Prof. E. Gardner in part ii. of *Ancient Egypt* for 1915. It is an ivory statuette with gold ornaments and details, 6½ in. in height. The resemblance of the figure to that of the famous Snake Goddess found by Sir A. Evans at Knossos is obvious. But it resembles not so much any art of ancient Greece as that of Gothic work of the thirteenth century. At the same time, the character of the materials seems to preclude the possibility of forgery. She wears a dress of Cretan type, and her head is adorned with a splendid crown, on which a gold ornament was probably fixed. The statuette exhibits for the first time a treatment of the human figure which is comparable with the fine studies of animals characteristic of Cretan or Mycenæan art. It may be placed not far from the high-water mark of Cretan pottery, and it may go back to the Middle Minoan age. This new discovery emphasises more than ever the contrast between the art of Crete and that of ancient Hellas. It is much to be regretted that this fine work of art has not found its home in our national collections.

MR. T. ERIC PEET has issued in the Publications of the Manchester Museum, No. 75, an account of the Stela of Sebek-khu, which contains the earliest record of an Egyptian campaign in Asia, one of the most important documents ever found in Egypt. It was unearthed at Abydos in 1901 by Prof. Garstang, and is now in the Manchester Museum. It measures 16½ by 10 in., and the inscriptions and representations are somewhat carelessly incised. Its importance lies in the fact that this is a record of an early campaign in a period hitherto unknown preceding the age from which date the Hyksos invasion, the great wars of Thotmes III. and Rameses II., down to the campaign of Sheshonk, mentioned in the Old Testament. It represents the beginning of reprisals in the Asiatic field at the beginning of the twelfth dynasty. The people now attacked by Egypt were the Mentu of Sebet, or nearer Asia, and the Mentu were an Asiatic tribe living close to the Egyptian frontier. On this occasion the Mentu were aided by their allies, the Retenu, probably inhabiting the Peninsula of Sinai. Sekmem, the place attacked, was somewhere in Palestine. However the details of the campaign may be worked out, this Stela remains our best authority for Egyptian conquest in Asia prior to the eighteenth dynasty.

ACCORDING to the *Victorian Naturalist* for March, examples of parasitic Copepods belonging to the family Monstrillidæ, have been discovered for the first time in Australia by Mr. J. Searle, but as yet their specific identity has not been determined. These small crustacea are parasitic on Serpulid worms, whence they escape, by rupturing the body wall of the host, to liberate their ova. This they do as free-swimming organisms, but lacking a functional alimentary canal, death ensues on the completion of the reproductive functions.

IN the *Australian Zoologist* for February, Mr. Allan McCulloch gives a brief, but extremely interesting account of the hitherto unrecorded migration of the larval eel-gudgeon (*Galaxias attenuatus*) from the sea to fresh water. He found numbers of these larvæ, about 38 mm. long, and quite transparent, making their way through the surf into a small fresh-water stream about 6 ft. wide. Very little is known of the habits of Galaxias, but some interesting notes on the occurrence of *G. truttaceus* in damp soil in Tasmania have been made by Mr. T. Hall and Mr. J. Fletcher. It would seem that this species is capable of burrowing into soft earth to a depth of eight or nine inches, when the water dries up in times of drought, and there æstivating until released by the rains.

How insect pests extend their range into new and distant areas is shown by Mr. W. J. Rainbow in the *Australian Zoologist* for February, where he records the occurrence of the carpet beetle (*Attagenus piceus*) in woollen goods imported from London by a large drapery establishment, and of a West Indian longicorn beetle (*Eburia binodosa*), which had worked its way out of of an imported oak chair. This insect, doubtless in a similar manner, has also made its way into England, but so far with no evil results. The discovery of the carpet beetle in Australia is, however, a more serious matter, for much damage had been done before it was detected. Hence there is a possibility that its ravages may spread.

THE peculiar methods of feeding displayed by the starfish are well known; but Mr. H. N. Milligan, in the *Zoologist* for April, describes for the first time the means adopted for disposing of a victim so unusual as a pipe-fish. After some experimenting the body was seized between two of the arms, and held in position by means of the suckers, while the three remaining arms were made to serve as the legs of a tripod. The upper portion of the abdomen of the still living captive was brought immediately under the mouth of the captor, when the stomach was everted in the usual manner to envelop this unwieldy morsel, which was held there until hunger was appeased. No similar case seems ever to have been recorded. Two excellent figures add not a little to the interest of this strange record.

FROM the annual report of the Zoological Society of London, it is apparent that the war has not only curtailed its income, and made rigid economy necessary, but it has further hampered the smooth running of the menagerie. More especially is this true in regard to the fish supply. Early in August the contractor was unable to continue his supply, and fish had to be bought daily at from $4\frac{1}{2}d.$ to $7d.$ per pound, instead of $1\frac{1}{2}d.$ per pound. Then the inspector of the Fishmongers' Company at Billingsgate came to the rescue, and allowed the society to take away from the market quantities of fish good for immediate consumption, but not fit to distribute through the retail trade. But this source of supply failed when the cold weather came. Happily, so far it has been possible to arrange for a regular supply from Grimsby. We would suggest that should this fail recourse should be had to netting some of our inland waters for "coarse fish," of which there must be an abundance for a long time to come.

IT is extremely gratifying to learn, from the spring number of *Bird Notes and News*—the organ of the Bird Protection Society that the colonies of the great skua are still increasing on the Shetlands, though they have to be guarded jealously against the raids of the egg-collector. Strenuous efforts are being made to save from extermination the red-throated diver, the black-tailed godwit, and the harrier. It is to be hoped that these efforts will meet with their due meed of success during the coming nesting season. The largest colony of great black-backed gulls in Great Britain, we are told, is to be found on Noss. But this does not afford us unmixed satisfaction. This bird is ruthlessly destructive of the eggs of other species, and of late years has become unduly numerous; measures might, therefore, with advantage, be taken to reduce their numbers. In the same number we learn with much pleasure that the choughs and buzzards are more than holding their own in Cornwall, thanks to the efforts of the society's watchers.

THE report for 1913 of the periodic variations of glaciers (*Annales de Glaciologie*, vol. ix. (1914), pp. 42–65) includes the Swiss, Eastern, and Italian Alps, and gives some information about the glaciers of Norway, Russia, the Himalayas, New Zealand, and North America, especially Alaska. The Alpine glaciers, on the whole, are still retreating, though a few advances are recorded. For instance, of sixty-one Swiss glaciers, twenty-five continued to recede in 1913, and ten probably did the same, while only one certainly and ten probably advanced; the movements of the rest being doubtful. In the other two Alpine districts the observations are less numerous, but on the whole they point in the same direction. In other countries the evidence, which, however, is sometimes rather imperfect, shows that glaciers in the same neighbourhood are uncertain in their movements, but are generally receding, the small being more sensitive than the large to the annual snowfall. This, however, seems certain, that in the Alps the ice-streams have not nearly regained the ground which they began to lose rather more than half a century ago. At present information about these variations, though in a few cases it goes back some three centuries, is too imperfect to admit of any satisfactory explanation. Oscillations such as have been observed during several years, including the last one, are probably due to variations in the temperature and snowfall during one or more preceding seasons, but the great advances, with corresponding thickening of the ice-streams, such as those which culminated approximately in 1820, and in 1850, lasting, perhaps with occasional slight recession, until well past 1860, must be due to a more general cause. For determining this the records, accumulated by the Commission Internationale des Glaciers, will be ultimately very valuable.

Bulletins 41 and 42 of the Agricultural Research Institute, Pusa, deal with investigations on sugar-yielding plants in India. In No. 41 Mr. H. E. Annett deals with sweet sorghum and the variation in composition of this crop during growth, giving extensive and valuable data resulting from experiments and analyses. He concludes that owing to the high glucose ratio and other difficulties, sweet sorghum is not worth growing in India as a source of sugar, but that it seems likely to prove a valuable source of fodder, being a fairly quick-growing crop; also that soon after flowering the plant shows no increase in total weight or in sugar, hence it should not be allowed to grow beyond this stage, after which its value as fodder decreases. Bulletin 42, by Mr. G. Clarke and others, deals with cane-crushing. It is pointed out that in order to ascertain the value of a variety of sugar-cane and the possibility of its succeeding as a field crop in any given district, it is necessary to investigate in the field the general crop characters; in the laboratory the sugar content and quality of the juice; and in the mill what proportion of juice and total sugar can be extracted, and the cost of doing so. Tabulated details are given, representing the results of a long-continued series of experiments on sugar-crushing and the sucrose yields of different varieties of cane; and the authors conclude that future increase in area under cane in the United Provinces and in number of mills will depend upon the introduction of cheaper and quicker methods of dealing with the produce, the present crop being as much as the bullock-power of the provinces can deal with, and the industry unlikely to increase unless some cheaper form of crushing is introduced.

The general deficiency of rainfall in March as shown by *Symons's Meteorological Magazine* for April in the tentative table for the British Isles is of more than ordinary interest. The wet spell which was so characteristic of the recent winter has fortunately come to an end. Statistics previously given by the British Rainfall Organisation show that the aggregate rainfall for the four months—November, 1914, to February, 1915—was 168 per cent. of the average over England and Wales, and more than 200 per cent. of the average over the Thames Valley. The rainfall table for March shows a totally different result. Rain measurements are given for fifty-five stations scattered over the entire kingdom, and of these only five have the total rainfall for the month in excess of the average; they occur along the east coast of England and in the north of Scotland. The greatest excess from the normal occurs at Gordon Castle, where the rainfall was 147 per cent. of the average, and at no other station was the percentage of the average more than 110. At twenty-one stations out of fifty-five the rainfall was less than 50 per cent. of the average, and at two stations, Launceston and Killarney, the rainfall was less than 25 per cent. of the average. For the British Isles as a whole the rainfall was 58 per cent. of the average, whilst for the several parts of the United Kingdom the percentages are: England and Wales, 54; Scotland, 79; and Ireland, 40.

Circular No. 24, issued by the Bureau of Standards, contains a list of the papers which have appeared in each of the ten published volumes of the Bulletin and a classified list of the papers, with a short account of the contents of each. The Bureau also announces that in future the Bulletin will be supplied to subscribers at one dollar a volume unbound, plus 50 cents for postage to this country. Subscriptions should be sent in advance to the Superintendent of Documents, Washington, D.C. We have no doubt there are many in this country who will take this opportunity of getting a valuable series of papers which up to the present could only be found in the libraries of scientific societies.

In a paper read before the Royal Society of Arts on April 14, and published in the Journal of the Society for April 18, Mr. T. Thorne Baker gave a short account of the industrial uses to which radium is at present put. Radium residues left over after treatment of the ores may or may not improve the growth of plants, according to the materials other than radium contained in them, but if the metals have been removed during the process of extraction of the radium the residue in suitable quantities appears to facilitate growth. These residues may also be utilised in the treatment of disease and as bactericides. In the discussion which followed the reading of the paper, it was pointed out that in much of the plant growth work which had been done with radium, sufficient care had not been exercised to enable it to be affirmed with certainty that the increased growth found in some cases was not due to the nitrates and phosphates in the residues, rather than to the radium. Until this question is settled, there appears no justification for the use of radium in horticulture.

An account of "Röntgen Motion Pictures" is given in the *Scientific American* for April 3. An illustration of the apparatus designed for the purpose of producing them, by F. Dessaur, is also given, together with a number of somewhat indefinite results. During the meeting in London of the International Congress of Medicine, we had the advantage of seeing this remarkable arrangement in action, and we brought away the impression that it added at least a new terror for the patient who has to come in contact with the already rather alarming armament of a modern radiologist. While it is certainly a model of ingenuity, the plate-changing operation is accompanied by a good deal of noise and clatter, and there is no doubt that beyond fixation of the image little or no more is to be learned from the results than can be ascertained by an ordinary screen examination with a far simpler outfit. The apparatus, however, is not without special significance to us in these days. To have brought it to perfection must have involved great expenditure of time and money, nor is it likely, on account of its price and size, to find a very ready sale. Yet this sort of thing is done in Germany, and done well, to attract and to create the impression of progress and thereby to catch the market in X-ray apparatus generally. In the end it pays and incidentally leads to much interesting work, as well as fostering a spirit of enterprise.

WE have received from Kodak, Limited (Wratten Division), a copy of the third edition of their booklet on photomicrography. As compared with the second edition, it is somewhat enlarged, and it comprises within its thirty-six pages simple and straightforward instructions as to the arrangement of the apparatus, undisfigured by diagrams and directions with regard to the illuminating system that are too often found in the text-books, although they can never be realised. We refer to "parallel light," and so on. The price of the pamphlet is 3*d*., and, of course, its strong point is the photographic side rather than the microscopical side of the art, and especially the use of colour filters. The spectrum transmissions of nine filters are given, and also the dominant wave-lengths of ten, most of the latter being a combination of two. Another table gives the absorption bands of the eighteen principal stains used in microscopy, with the suitable filters for securing maximum contrast in the photograph. Other tables give the relative sensitiveness of various Wratten plates to different light sources, and exposure factors for different focal lengths and apertures of objectives, for various magnifications, for different light sources, and for fifteen different light filters, in connection with the "M" plates. The illustrations include two excellent reproductions of stained preparations, and two little colour filters in a pocket of the cover, for viewing them through, serve to demonstrate the potency and usefulness of colour filters.

THE March number of the *Journal of Chemical Technology* contains a report of a special meeting of the London Section of the Institution of Chemical Technologists which was held on March 11 to discuss "The Future of British Chemical Industry." In opening the discussion, Colonel C. E. Cassal emphasised the fact that the chemical profession in this country stands alone among the professions in that it is utterly without organisation, and is split up into a number of different camps. At the present time there is little sympathy between the college laboratory and the technical laboratory; it is on the closer union of these that future progress of chemical industry will depend. Colonel Cassal, in referring to the ignorance of the general public and of State departments as to the value of science, illustrated his remarks by a reference to the now notorious advertisement of the Royal Arsenal, referred to in NATURE of April 1 (p. 119), and to the organisation of "British Dyes, Ltd." Mr. W. J. Dibdin remarked that the chemical department of the London County Council, of which he was formerly the chief, effected a saving of 10,000,000*l*. capital expenditure in the plant necessary for dealing with the sewage of London. The general trend of the debate was that only by the education of the chemist supplemented by the education of the employer will it be possible successfully to fight Germany in the field of industrial chemistry.

ALTHOUGH it is perhaps one of the minor chemical products, allyl alcohol has been used extensively in research, and is by far the most readily accessible of the series of unsaturated alcohols. Originally prepared through the iodide from glycerol, it was a very costly product, but came into common use when Tollens showed that it could be prepared directly from glycerol by heating it with oxalic acid. A greatly improved preparation has recently been described by Dr. Chattaway in the Journal of the Chemical Society (vol. cvii., p. 407). Five hundred grams each of glycerol and of anhydrous oxalic acid are heated at 100° in a vacuum during four or five hours, whilst a certain amount of formic acid is distilled out; the product, which contains much dioxalin, is then decomposed by heating under ordinary pressure to 220°–240°, when carbon dioxide is set free and allyl alcohol and allyl formate are produced. The oxalic acid is decomposed almost completely, leaving a residue of glycerol, which can be made up again to 500 grams, mixed with 500 grams more of oxalic acid, and used over again; this can be repeated four or five times. The waste of material is therefore very small, and the glycerol used up is converted almost quantitatively into allyl alcohol, whilst the oxalic acid is converted on one hand into carbon dioxide, and on the other into formic acid.

THE importance, both to the manufacturer and the consumer, of having at disposal adequate facilities for the scientific investigation and testing of the quality of textiles is very great. At the present time when immense quantities of such materials are being manufactured for military and naval purposes such facilities are exceptionally valuable. The Public Textile Testing and Conditioning House carried on under the auspices of the Corporation of Belfast, and located in the Municipal Technical Institute of that city, has just issued the fifth edition of its regulations and schedule of charges, and this publication indicates very strikingly the extent to which textile testing has now been elaborated and perfected. The Belfast testing house is one of the more recently opened, having been established in the year 1910 by the corporation at the direct request of the textile trades of Belfast and district. The house is carried on under Parliamentary authority, has power to grant certificates respecting the articles submitted for examination, and certificates so issued are receivable as evidence in a court of law. The schedule of charges shows that a very wide range of tests are undertaken in the testing house. The tests include physical, chemical, and microscopical investigations of fibres, yarns, cloths, and bleaching and dyeing materials. A noteworthy section of the testing scheme is that concerned with the determination of the cause of defects in cloth, more especially such causes as are classed under the technical heading of "tendering."

PART 4 of the Proceedings of the Institution of Mechanical Engineers for 1914 has just been issued, and contains the recommendations of the refrigeration research committee. There are also given charts of entropy and total heat for each of the three substances in common use for refrigerating purposes, viz., carbon dioxide, ammonia, and sulphur dioxide. The use of these charts is explained in a note by the chairman of the committee, Sir J. A. Ewing. The chart for carbonic acid uses Dr. Mollier's figures, but with British units of pressure and with some additions based on the recent researches of Prof. Jenkin and Mr. Page. For the other two substances the experimental data available are much less complete. For ammonia, the chart must be regarded as no more than provisional; values given by Prof. Goodenough and Mr. W. E. Mosher have been adopted. The chart for sulphurous acid is also provisional; values given by Dr. J. Hýbl have been employed. Tables giving the properties of these substances are also included.

ERRATUM.—In NATURE of April 29, p. 238, col. 1, line 10 from bottom, for "solstice" read "equinox."

OUR ASTRONOMICAL COLUMN.

COMET 1915*a* (MELLISH).—The following is a continuation of the ephemeris of Mellish's comet (1915*a*) taken from *Astronomische Nachrichten*, No. 4796:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
May 6	18 53 31	−14 46·2	
8	57 6	16 25·9	6·5
10	19 0 55	18 17·3	
12	5 2	20 22·2	6·2
14	19 9 32	−22 42·1	

The comet is rapidly moving southwards, and is situated a little to the north of π Sagittarii.

A third series of elements and an ephemeris of this comet are published by Mr. R. T. Crawford, of the Berkeley Astronomical Department, in the Lick Observatory Bulletin, No. 270. It is pointed out that there seems to be a similarity between these elements and those of comet 1748 II., and computations are being undertaken to test the possibility of the identity.

ORBIT OF JUPITER'S NINTH SATELLITE.—A more rigorous reduction of the elements of the orbit of the ninth satellite of Jupiter is given by Seth B. Nicholson in the Lick Observatory Bulletin, No. 271, this being a continuation of the investigation previously published in the Bulletin, No. 265 (see this column for April 1). The following are the new elements derived:—

Epoch and Osculation = 1914 August 21·0 G.M.T.

$$M = 135^\circ\ 57{\cdot}2'$$
$$\left.\begin{aligned}\omega &= 359^\circ\ 53{\cdot}5'\\ \Omega &= 310^\circ\ 30{\cdot}6'\\ i &= 156^\circ\ 57{\cdot}9'\end{aligned}\right\}\ 1914{\cdot}0$$
$$e = 0{\cdot}1105$$
$$\mu = 0^\circ{\cdot}4518$$
$$P = 2{\cdot}182 \text{ years}$$
$$\log a = 9{\cdot}2192$$

As a result of the alteration in the elements it is stated that the errors in the final elements do not exceed 2 per cent. of their values. An ephemeris for the coming opposition is promised at an early date.

THE SATELLITES OF URANUS.—Two communications regarding measures of the satellites of Uranus are published in the Lick Observatory Bulletin, No. 269. The first, by Prof. R. G. Aitken, were made in 1914 with the 36-in. refractor using a 350 power eyepiece. An interesting opportunity presented itself on July 21 to estimate their relative brightness. The four satellites were all south of the planet, Ariel and Umbriel almost in line with it, and only a few seconds of arc apart. Ariel was seen at the first glance, and was conspicuously visible while measuring the other satellites; Umbriel was seen with much more difficulty, and made no impression on the eye except when special efforts were made to see it. By direct comparison it was estimated to be from ½ to ¾ magnitude fainter than Ariel. The latter appeared to be a magnitude fainter than Titania; Oberon, from ¼ to ½ magnitude fainter than Titania. While these observations were being made the sky was very clear, the seeing good, and the planet screened by an occulting bar. Measures of the satellites were made by Mr. S. B. Nicholson from photographs taken with the Crossley reflector at the Lick Observatory during 1914. The positions of Uranus and of the satellites were measured in rectangular co-ordinates, so that the distances of the satellites from either Uranus or one of the outer satellites could be obtained.

THE GREENWICH SECTION OF THE ASTROGRAPHIC CATALOGUE.—The third volume of the Astrographic Catalogue 1900·0 deals with the Greenwich Section, declination +64° to +90°, and is deduced from photographs taken and measured at the Royal Observatory. The first portion contains a catalogue of 2212 stars within 3° of the north pole in standard rectangular co-ordinates. In the original scheme of publication this, the third volume, should have included a general discussion of results, but the Astronomer Royal has deferred this discussion for a fourth volume. The present catalogue includes: (1) stars used as reference stars for the astrographic plates; (2) other stars contained in the catalogues of the *Astronomische Gesellschaft;* (3) stars contained in Carrington's Catalogue (1855·0); and (4) stars in the Bonn Durchmusterung Zone, 80°. The right ascensions and declinations depend throughout on the places of stars observed with the transit circle at Greenwich in the years 1897 to 1905. The proper motions given in the Greenwich Catalogue have been used in forming the constants of the plates. In the main catalogue the epoch is 1900·0. The stars are arranged in zones of declination 1° wide, and the photographic magnitudes are on the scale of Prof. E. C. Pickering's north polar sequence.

RECENT PAPERS IN THE "ASTRONOMISCHE NACHRICHTEN."—The following is a continuation of the chief contents of some of the earlier numbers of the *Astronomische Nachrichten* referred to in this column last week:—No. 4785: Trial of the photographic magnitude-scale of the bright Pleiades stars, by E. Hertzsprung. No. 4784: Observations of Halley's comet 1910 II., made at the Chamberlin Observatory of the University of Denver, by Herbert A. Howe. No. 4783: Photographic observations of some bright double stars, by E. Hertzsprung; observations on the brightness and form of comets, by M. Ebell. No. 4782: The special motions of stars with known parallaxes, by R. Klumak. No. 4781: Observations of planets and comets made with the 360-mm. refractor of the Copenhagen Observatory, by C. F. Pechüle and E. Strömgren and R. Andersen. No. 4780: Observations of the planet Venus, by W. Rabe; definite orbit of comet 1906 VII. (Thiele), by E. Waage. No. 4779: Observations of the planet Mars, by H. E. Lau; observations of the variables U Sagittæ and R. S. Vulpeculæ, by M. Maggini. No. 4778: Test for variability of 113 Herculis and α Sagittæ, by E. Hertzsprung; photographic measures of the magnitude difference between the two components of ν Draconis, by E. Hertzsprung; observations of the variables o Herculis, g Herculis, and RZ Cassiopeiæ, by M. Maggini. No. 4777: Mean elements of sixty minor planets, by M. Brendel; ephemeris for Polarissima (BD +89° 37′) for 1915, by L. Courvoisier.

SMITHSONIAN INSTITUTION EXPLORATIONS.

THE report of Explorations and Field-work of the Smithsonian Institution for 1913 (Smithsonian Miscellaneous Collections, vol. lxiii., No. 8, 1914), including the National Museum, Bureau of American Ethnology, and Astrophysical Observatory, represents much activity in various directions, even if, owing to scarcity of funds, some promising enterprises were abandoned.

In geology the most important work was a survey by Dr. C. D. Walcott of the Robson Peak district in British Columbia and Alberta, and the Field region in British Columbia, which he regards as one of the finest geological sections in the world (see NATURE, December 24, 1914, p. 468). A series of admirable photographs, one of which (Fig. 1) is here reproduced by the courtesy of the secretary of the Institution, illustrates the splendid mountain and glacier scenery of this region. At Field a large collection of specimens was made from the great Cambrian fossil quarry. Mr. F. Springer's exploration in Illinois produced numerous examples of fossil crinoidea, and in Montana Mr. E. Stebinger discovered a new ceratopsian or horned dinosaur, the first example possessing a complete articulated tail and hind foot, which contributes greatly to our knowledge of the skeletal anatomy of this group of extinct reptiles. Dr. W. L. Abbott continued his work in Kashmir, his acquisitions including a curious silvery-grey shrew about 74 millimetres long, quite different from anything he had before seen, and a fine snow leopard with complete skeleton.

In the field of anthropology Dr. A. Hrdlicka continued his exploration in Peru with the object of determining the relations of the ancient Peruvians of the mountains with those of the coast, with the result that he finds no evidence of any great antiquity of man in Peru. Except the cemeteries or burial caves of the coast or mountain people, there was no sign of human occupation and no trace of anything older than the well-represented pre-Columbian Indians, neither the remains of the coast nor of the inland people disclosing an antiquity greater than some twenty centuries. In the Antilles Dr. Fewkes finds a race of sedentary people possessing a form of culture extending from Trinidad to Porto Rico, preceded in Cuba and Hayti by a cave-dwelling race, and followed by the comparatively late Carib immigration.

As regards the Indian tribes of the States, the most interesting information is that collected by Mrs. M. C. Stevenson among the Tewa tribe, where the rain-priests retire into an underground ceremonial chamber, symbolising the lower world, and, after undergoing a strict fast, pray for rain. It is startling to learn that this tribe still propitiate the rattlesnake in order to prevent it from injuring them, by a quadrennial human sacrifice, either of the youngest female infant or of an adult unmarried childless woman. The victims are drugged until they seem to be dead and are then exposed to the sacred snakes, who are allowed to devour the corpse. The skeleton is then buried with offerings under the floor of an adjoining room.

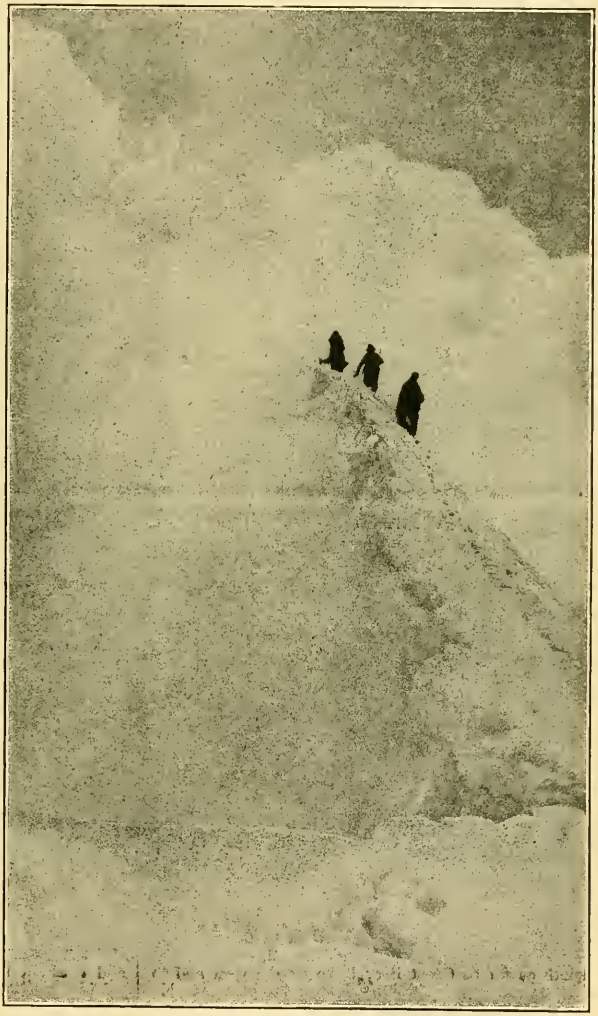

Photo.] FIG. 1.—Summit of Mount Resplendent, British Columbia. [*P. L. Tait.*

The account of the tattooing ceremony among the Osage tribe (Fig. 2), by Mr. F. La Flesche, is noteworthy. Formerly the honour was restricted to warriors distinguished in a campaign. Now, as they have gained wealth, it has become a means by which any person can publicly display his affection towards a relative.

Mr. V. Stefánsson contributes to Museum Bulletin No. 6 of the Department of Mines, Canada, a paper on prehistoric and present commerce among the Arctic coast Eskimo. This was, as might have been anticipated, usually conducted by sea. The main route ran along the coast from Mackenzie Bay on the east to King William Island on the west, diverging to the north through Victoria Island, and reaching south as far as Great Bear Lake on the west and to Thelon River and Chesterfield Inlet on the west. He finds a certain tribal specialisation of industries and some division of labour resulting from the varied natural resources of this wide area. But each tribe believes the articles made by its members to be superior to those of neighbouring tribes. Though the people are very conservative, there is a constant interchange of manufactures between distant districts, and with this arises a commerce of ideas which are readily assimilated with the indigenous beliefs and practices.

Bureau of American Ethnology.

FIG. 2.—An Osage Indian with tattooing.

RECENT WORK ON VERTEBRATE PALÆONTOLOGY.

UNDER the direction of Prof. H. F. Osborn a number of expeditions have been dispatched from the American Museum of Natural History to collect the mammalian faunas of the Lower Eocene Wasatch and Wind River beds of Wyoming, and the collection of such remains in that institution is consequently very large, especially as it includes the extensive series brought together by Prof. Cope, which was purchased in 1895. The stratigraphical observations made during these expeditions and the careful record of the exact horizon of each fossil have rendered it practicable to correlate the various faunas, and to trace out the evolution of the different species and groups in a manner which was previously impossible. With the object of putting these new facts before the scientific public, Messrs. Matthew and Grainger have undertaken a revision of our knowledge of these faunas, the first portion of which appears as vol. xxxiv., art. 1 (pp. 1–103), of the Bulletin of the American Museum of Natural History. This, which is by Dr. Matthew alone, treats of the creodont carnivora, seven families of which are represented in these formations, and of which three genera and a large number of species are described as new.

Quarto Bulletin No. 89 of the U.S. National Museum is devoted to the first portion of a descriptive account of the osteology of the armoured dinosaurs, with special reference to the genus Stegosaurus, by Mr. C. W. Gilmore. The memoir, which includes 136 quarto pages and thirty-six plates, is dated December 31, 1914, but copies did not reach this country until the latter part of the following March; it is based almost exclusively on specimens in the collection of the National Museum, and gives the first detailed description of the entire osteology of Stegosaurus. The material includes considerable portions of the skeletons of several individuals, among which the one most nearly approaching completeness, and which alone exhibits the true arrangement of the dermal armour, is the type of *S. stenops*. With few exceptions, the entire series of stegosaurian remains were obtained from two quarries, situated respectively in Albany County, Wyoming, and Fremont County, Colorado.

Nine species of the genus—all American—are at present provisionally recognised, the European forms described by Owen as Omosaurus being regarded as generically distinct, under the name of Dacentrurus, the original designation being pre-occupied. In some of the later restorations of Stegosaurus the double series of upstanding dorsal plates were ranged alternately, and the number of pairs of spines on the tail reduced from four to two; in the latest restoration, however, there is a return to the paired arrangement of the plates, and the retention of four pairs of tail-spines. Stegosaurus, which attained a length of about 20 ft., had relatively small and feeble teeth, which appear to indicate that it fed on succulent plants. The structure of the feet suggests that these reptiles inhabited low, swampy tracts rather than uplands; and there is good reason to believe that the members of the genus are descended from bipedal dinosaurs specially adapted for locomotion on land.

Until quite recently remains of man-like apes were almost unknown from the Indian Siwaliks, the only specimens being a canine collected by Falconer and Cautley, and a palate from the Punjab described in 1879 by Mr. Lydekker as Palæopithecus. During the past few years the collectors employed by the Geological Survey have, however, brought together a considerable series of teeth and fragmentary jaws of these and other Primates. These form the subject of an illustrated article contributed by Dr. G. E. Pilgrim to the February number of the Records of the Geological Survey of India (vol. xlv., pp. 1–74). Among the remains of man-like apes, a considerable number are referred to the European genus Dryopithecus, of which the author recognises three Siwalik species. These specimens include one exhibiting two of the upper molars *in situ*, which were previously unknown. A separate tooth, characterised by the roughness of its enamel, is described as a new genus, under the name of *Palaeosimia rugosidens*.

The greatest interest attaches, however, to specimens described as *Sivapithecus indicus*, and referred to the family Hominidæ. This genus and species were originally described on the evidence of a single tooth, but the author now proposes to take as the type part of a lower jaw with several teeth; this, of course, being totally unjustifiable. The author gives an ideal restoration of the whole mandible, but it is somewhat difficult to realise all the evidence on which it is based. A special feature of the restoration is the extreme shortness of the symphysis, which is found elsewhere (save in the Hominidæ) only in gibbons. The author is at great pains to show that Sivapithecus is generically distinct from Palæopithecus, but as the latter is definitely known only by the palate, his arguments do not appear absolutely conclusive, especially when it is borne in mind that the occurrence of a number of types of ape-like creatures in the Siwaliks is unlikely.

The author concludes his article with observations on the evolution of the Anthropoidea, in the course of which it is suggested that Sivapithecus should take its place as a side-branch from the main stem which gave rise to man himself. On the other hand, the Piltdown Eoanthropus, which Dr. Smith Woodward considers to be a direct ancestor of man, is thrown altogether out of the line of human ancestry. While the article is full of interest, further consideration is advisable before the author's views are accepted in their entirety.

In an earlier paper in the same serial (vol. xliv., pp. 265–79) Dr. Pilgrim describes and figures a number of Siwalik teeth referable to the creodont genus Dissopsalis, named by himself in 1910. The genus is regarded as forming the summit of a branch of the Hyænodontidæ, running nearly parallel to the one culminating in Hyænodon and Pterodon. It is also shown that a Siwalik tooth described by the present writer as *Hyaenodon indicus* is really inseparable from *Hyotherium sindiense*, named by him at an earlier date. Later on in the same issue Dr. Pilgrim points out that the name Progiraffa proposed by himself for a Siwalik giraffe-like ruminant, has to give place to Propalæomeryx of the present writer.

R. L.

THE UNITED STATES BUREAU OF STANDARDS.

IN his report for 1913–14, Dr. Stratton, the director of the U.S. Bureau of Standards, shows how very extensive and varied is the work carried on at the Bureau. During the past few years its growth has been exceptionally rapid, and increased accommodation is still asked for. Much of the work carried on is strictly technical and includes tests on paper, paints, and varnishes, the shrinkage of wools, the properties of lime and cements, and the study of ceramic glazes. In the electrical division an important electrolysis survey was conducted in Springfield, Massachusetts, and useful information obtained with regard to the bonding of tracks, etc.

The unfortunate accident to the *Titanic* centred attention on possible methods of detecting the near presence of icebergs, and assistants of the bureau conducted experiments on two naval vessels. The general conclusions reached are that the temperature variations in parts of the ocean far removed from ice are often as great and as sudden as in the immediate neighbourhood of icebergs, and that it is not possible to draw positive conclusions as to the absence or presence of icebergs from the temperature variation of sea-water. An attempt was also made to detect by means of submarine telephones, the submarine echoes from the submerged portion of a large iceberg. Sound waves were produced by striking the ship's bell under water. The experiments were not completed owing to lack of time and facilities, but the results obtained merit further trials.

Researches of a strictly scientific nature are numerous. One of considerable interest is the determination of standard wave-lengths throughout the entire spectrum. This is being carried out in accordance with the recommendations of the International Solar Union, and the results, while needed mainly by men of science, will also be of value in the industries. For example, the spectroscopic analysis of steel and other substances cannot be successfully undertaken until the characteristics of the spectra of the constituents are more accurately observed.

Another optical research deals with the transmission of glass for the ultra-violet rays, mainly with a view of determining their fitness for spectacle-making.

An interesting innovation is the establishment of standards of radiation in the form of incandescent lamps. In these standards the intensity of the radiant energy per unit area at unit distance from the lamp, has been established in absolute value. A long-felt want has thus been supplied.

In the chemical department work is in progress on the methods and standards employed in volumetric analysis. The final scheme for this research was prepared after criticisms and suggestions had been received from about 150 experienced chemists. A beginning has been made with the study of acidimetry and the subject of indicators. The quality of chemical reagents on the market is also being investigated. It has become the practice of many well-known dealers to attach labels to the bottles containing reagents, setting forth the nature and amount of the impurities. In many cases it has been found that the labels do not state the truth, and as a consequence some action will probably be taken. One suggestion is that the bureau shall purchase material and assume all the duties of bottling and sale.

In the division of metallurgy, among other interesting results are included the melting points of various metals. The results given are:—Nickel, 1452° C.; cobalt, 1478°; iron, 1530°, manganese, 1260°; chromium, 1520°; vanadium, 1720°; and titanium, 1795°. It is stated that accurate measurements of the melting point can be made with the micropyrometer on samples as minute as 0·001 milligram. The micropyrometer has also been employed to measure the monochromatic emissivity of microscopic samples. This constant has been determined for some twenty elements. It is expected to determine the melting points and emissivities of all the available refractory elements and of numerous oxides.

One of the most important recommendations of the director is to establish a radio-laboratory at the bureau. The importance of wireless telegraphy to the United States Government is pointed out, and a grant of 10,000*l.* for the construction of such a laboratory is asked for. For maintenance an additional 2000*l.* is required.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERYSTWYTH.—Prof. Alexander Findlay has been appointed Thomson lecturer in chemistry for the session 1915–16 in the United Free Church College, Aberdeen.

CAMBRIDGE.—The Linacre lecture will be delivered by Prof. E. H. Starling, in the anatomy lecture-room, at 8 p.m., Thursday, May 6, on the governor mechanism of the heart. The Rede lecture will be delivered by Dr. Norman Moore, at 5 p.m. of the same day, in the Senate House, on St. Bartholomew's Hospital in peace and war.

In view of the difficulties of the present financial situation, the Special Board for Biology and Geology has decided to allocate only such sums of money from the Gordon Wigan Fund as are necessary to prevent the extinction of research work already in progress. The grants made are: 10*l.* to Prof. Hughes, for research among the Pliocene deposits of the Cambridge district; 40*l.* to Prof. Punnett, to ensure that the Botanic Garden Syndicate will continue to offer special facilities for plant-breeding experiments; and 21*l.* to Mr. H. Scott, curator in entomology, for the care and development of the collections of insects.

SHEFFIELD.—Sir Joseph Jonas has given the University 5000*l.* to found, endow, and equip a laboratory, in connection with the applied science department, for testing metals, minerals, and similar substances, especially those involved in the production and manufacture of steel.

LADY HUGGINS, who died on March 24, leaving unsettled estate valued at 12,586*l.* gross, with net personality 12,109*l.*, made the following bequests, among others:—A sum not exceeding 1000*l.* to the Bedford College for Women (University of London); 500*l.*, and, if her estate is sufficient, a further sum of 500*l.* for the erection of a memorial in St. Paul's Cathedral to the memory of her husband; 1000*l.*, and, if her estate is sufficient, a further sum of 1000*l.* to the City of London School, Victoria Embankment, for the endowment of a scholarship for the study of astronomy, tenable at Cambridge, to be called the "Sir William Huggins" Scholarship; and a sum of not more than 300*l.* for finishing, editing, and illustrating the book on which she was engaged, being the life of her husband. The residue of the estate, if any, is also left to the City of London School.

WE learn from *Science* that Princeton University has received from Mrs. W. C. Osborn 25,000*l.* to establish the Dodge professorship of medieval history, and 20,000*l.* from an anonymous donor to endow a professorship of economics. Our contemporary also states that the Schools of Mines, Engineering, and Chemistry of Columbia University have received an anonymous gift of 6000*l.*, to be applied to the reconstruction and new equipment of the laboratories of quantitative, organic, and engineering chemistry in Havemeyer Hall; that a gift of 4000*l.* is announced from Mrs. S. W. Bridgham, daughter of a trustee of Columbia University from 1860 to 1903; and that Mr. G. W. Brackenridge has given to the University of Texas his yacht *Navidad,* valued at 20,000*l.*, to be assigned to the biological department of the institution. A preliminary survey of the Texas coast is to be made in the *Navidad,* starting from Port Lavaca.

THE ninth annual report, that for 1914, of the Apprenticeship and Skilled Employment Association, shows that in common with other bodies dependent for their support on voluntary contributions from the public, the association has suffered already financially as a result of the war, and would welcome an addition to its income. The work of the association has continued on its now familiar lines. Interesting tables are provided in the report classifying according to trades the numbers of boys and girls placed in employment by the various London committees. During the year 1914 the total number of boys placed was 532, and of these 60 went into office and clerical work, 47 took up mechanical engineering, 41 scientific instrument making, 40 electrical engineering (including wiring), and 34 motor work. Of the 333 girls who were found employment, 93 took up dressmaking, 34 office and clerical work, and 29 machining. The remaining girls were distributed among thirty-four different trades. Full particulars of the work of the association can be obtained from the offices, 53 Denison House, Vauxhall Bridge Road, S.W.

THE Benares Hindu University Bill was introduced in the Viceroy's Legislative Council at Delhi on March 22 by Sir Harcourt Butler, the vice-president, and the introduction of the Bill was carried *nem. con.* During the course of his speech, which is reported in the *Pioneer Mail* of March 26, Sir Harcourt Butler said:—"The main features of this University will be, first, that it will be a teaching and residential university; secondly, that while it will be open to all castes and creeds it will insist upon religious instruction for Hindus; and, thirdly, that it will be conducted and managed by the Hindu community and almost entirely by non-officials." The University is to be an All-India University. It is incorporated for the teaching of all knowledge, but will commence with five faculties of arts, science, law, Oriental studies, and theology. Many of the promoters desired to add a faculty of technology, and this desire has the full sympathy of Sir Harcourt Butler. The Governor-General will be Lord Rector, and the Lieutenant-Governor of the United Provinces of Agra and Oudh will be Visitor, of the University. The governing body will be a numerous and very representative Court, with an executive body in a council of not more than thirty members, of whom five will be members of the Senate. The academic body will be the Senate, consisting of not fewer than fifty members, with an executive body in the Syndicate. The Senate will have entire charge of the organisation of instruction in the University, and the constituent colleges' curriculum and examination and discipline of students and the conferment of ordinary and honorary degrees. The following large subscriptions have already been received:—Maharana of Udaipur, 1½ lakhs; the Maharaja Holkar, 5 lakhs; the Maharaja of Jodhpur, 2 lakhs, with a grant in perpetuity of 2000 rupees per month; the Maharaja of Bikanir, one lakh, with a grant in perpetuity of 1000 rupees per month; the Maharaja of Kashmir, a grant in perpetuity of 1000 rupees a month; the Maharaja Bahadur of Darbhanga, 3 out of 5 lakhs; and one lakh from each of the following—the Maharao of Kotah, Dr. Rash Behari Ghose, Dr. Sundar Lal, the Maharaja of Casimbazar, Babu Bijendra K. R. Chaudhri of Ghorepur, and Babu Moti Chand. The Maharaja Scindia of Gwalior has promised five lakhs of rupees and others have promised liberal donations, of which, in many cases, part payment has been made.

SOCIETIES AND ACADEMIES.

London.

Royal Society, April 29.—Sir William Crookes, president, in the chair.—H. **Hartridge** and A. V. **Hill**: The transmission of infra-red rays by the media of the eye, the transmission of radiant energy by Crookes's and other glasses, and the radiation from various light sources. The different eye structures were found by the authors to absorb infra-red rays of different length to approximately the same extent as would a layer of water of the right equivalent thickness. From the values of the percentage absorption of water at different wave-length they have, therefore, calculated the amount of heat absorbed by cornea, iris, and lens. The heat absorbed by the lens was found to be too slight for cataracterous changes to be due to direct action. The condition might still be caused, as Parsons suggested, by impairment in the nutrition of the lens brought about by the action of heat rays on the ciliary body and iris. Samples of Crookes's glasses were tested and were found to absorb the heat waves strongly, and also to some extent the ultraviolet.—E. **Beard** and W. **Cramer**: Surface tension and ferment action. The action of a ferment on a substrate is retarded or inhibited by extending the surface of the system in which the reaction proceeds. This effect has been studied in some detail in the system cane-sugar—invertase.—W. **Cramer**: Surface tension as a factor controlling cell metabolism. The considerations developed in this paper are based on the fact demonstrated experimentally that the action of ferments is conditioned by surface tension. The great surface development in the cell and the living organism must therefore produce conditions which markedly affect the action of ferments *in vivo* when compared with their action *in vitro*. It is shown how the cell may, through the factor of surface tension, control and regulate its metabolism. It is thus possible to form a conception of the chemical organisation of the cell without having to assume the existence of hypothetical membranes in the cytoplasm which are supposed to surround the different chemical systems and separate them from each other. Lastly, it is pointed out that if the conceptions formulated in this paper are correct, substances which are strongly surface active, but which do not affect protoplasm chemically, should exercise a profound effect on the metabolism of the cell. This expectation is realised in the action of narcotic and cytolytic substances.

Challenger Society, April 28.—Capt. Alfred Carpenter in the chair.—Dr. G. H. **Fowler**: Investigations on drift currents in British waters.—Dr. S. F. **Harmer**: Records of Cetacea stranded on the British coasts during 1913 and 1914. The paper was based on an arrangement which had been made by the Board of Trade, which had issued an instruction to coastguard officers to report the stranding of Cetacea by telegram to the British Museum (Natural History). In this way, and aided by written reports, sketches, and photographs supplied by persons on the spot, much valuable information has been obtained, and a certain number of interesting specimens have been secured. By procuring a blade of baleen, in the case of the whalebone whales, or the lower jaw, in the case of the smaller toothed whales, it has been possible to determine the species in a considerable proportion of the records. Seventy-six records were obtained during 1913, and fifty-seven during 1914. The outbreak of war was clearly responsible for the smaller number during 1914. The common porpoise proved to be far the commonest species, as might have been expected. Several records of the occurrence of the common dolphin were obtained, principally on the more exposed parts of the coast-line. Other species which were represented by several records were the bottle-nosed whale, the pilot-whale, the white-beaked dolphin, the bottle-nosed dolphin, Risso's dolphin, the lesser rorqual, the common rorqual, and Rudolphi's rorqual. The most interesting record was a Sowerby's whale, stranded at Rosslare in September, 1914. Contrary to expectation, the district where strandings were most numerous was the coast-line of Lincolnshire and Norfolk, though a number of specimens were found on the shore of the southern counties (see Nature, April 15, p. 182).

Paris.

Academy of Sciences, April 26.—M. Ed. Perrier in the chair.—Gaston **Darboux**: The representation on a plane of the surface of the fourth order which admits a conic as a double curve.—G. **Bigourdan**: Scintillation. Comparison with the undulations of instrumental images of celestial bodies. There seems to be no identity between scintillation and undulations, as might at first sight appear probable. More quantitative data are required for the undulations.—A. **Haller** and Edouard **Bauer**: The action of sodium amide on the allyldialkylacetophenones. The preparation of 3 : 5-dimethyl-3-ethyl and 3 : 3-diethyl-5-methylpyrrolidones.—A. **Laveran**: The artificial acentrosomic varieties of the Trypanosomes. For *Tr. Evansi* and *Tr. Brucei* the disappearance of the centrosome produced by the action of oxazine is permanent after three or four hundred passages through animals. Morphologically, this might be regarded as a new species, but its biological characters are unchanged. Animals immunised against trypanosomes with centrosomes have acquired immunity for the acentrosomic trypanosomes and inversely.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1914. Observations were possible on fifty-eight days, the results of which are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—A. **Perot**: Variation of the wave-length of the telluric lines with the height of the sun. Particulars of measurements made with an interference spectroscope installed at the Observatory of Meudon. A line of the B group of oxygen was chosen; the wave-length increased from morning to noon and then decreased.—E. **Bompiani**: Laplace equations with equal invariants.—L. **Bouchet**: Electric pressures acting at the surface of a liquid insulating sheet. The displacements are very rapid for conducting liquids such as water and mercury, but with turpentine, vaseline oil, benzine, and petroleum ether there is a slow displacement. The instantaneous depression was deduced graphically and a relation established between this figure and the strength of the field.—Ph. **Flajolet**: Perturbations of the magnetic declination at Lyons (Saint Genis Laval) during the fourth quarter of 1914.—C. **Sauvageau**: A new species of Fucus, *F. dichotomus*. This is distinguished from *F. platycarpus* by its ramification and by the cylindrical form of its receptacles.—Jules **Amar**: Principles of professional re-education. A discussion of the problem of the work possible for wounded soldiers discharged as cured; from the physiological point of view.—MM. **Viallet** and **Dauvillier**: A new radioscopic method for the localisation of projectiles.—H. **Morize**: The determination of the position of projectiles in the human body by radioscopy. Remarks on a note by Dr. Foveau de Courmelles (January 18) on the same subject.—Marc de Selys **Longchamps**: Autotomy and regeneration of the viscera in *Polycarpa tenera*.—Lucien **Semichon**: The use of heat for fighting insects and parasitic cryptogams in cultivated plants. Hot water may be used provided its temperature does not exceed 70° to 75° C. Details are given of the temperatures required to kill various forms of mould and larval pests.—Em. **Bourquelot**, M. **Bridel**, and A. **Aubry**: The biochemical synthesis of the β-mono-*d*-galactoside of ethylene glycol. The synthesis was effected with the aid of emulsin.

BOOKS RECEIVED.

Morale fondée sur les Lois de la Nature. Cinquième et Sixième Mille. By M. Deshumbert. Pp. 191. (London: Watts and Co.)

Proceedings of the Royal Society of Edinburgh. Session 1914–15. Part 1. Pp. 112. (Edinburgh: R. Grant and Son.)

A Study of Prolonged Fasting. By F. G. Benedict. Pp. 416. (Washington, D.C.: Carnegie Institution.)

The Water-Relation between Plant and Soil. By B. E. Livingston and L. A. Hawkins. The Water-Supplying Power of the Soil as Indicated by Osmometers. By H. E. Pulling and B. E. Livingston. Pp. 84. (Washington, D.C.: Carnegie Institution.)

The Absorption Spectra of Solutions as Studied by Means of the Radiomicrometer. By H. C. Jones and Collaborators. Pp. 202. (Washington, D.C.: Carnegie Institution.)

Joseph Pennell's Pictures in the Land of Temples. Plates xl+Notes. (London: W. Heinemann.) 5*s.* net.

DIARY OF SOCIETIES.

THURSDAY, MAY 6.

ROYAL SOCIETY, at 4.30.—Some Problems Illustrating the Forms of Nebulæ: G. W. Walker.—Observations on the Resonance Radiation of Sodium Vapour: Hon. R. J. Strutt.—Local Differences of Pressure near an Obstacle in Oscillating Water: Hertha Ayrton.

ROYAL INSTITUTION, at 3.—Advances in General Physics: Prof. A. W. Porter.

ROYAL SOCIETY OF ARTS, at 4.30.—Constantin Meunier et les Sculpteurs Belges de son Temps: M. Paul Lambotte.

LINNEAN SOCIETY, at 5.—Some Bird Problems: W. Percival Westell.—The Brown Seaweeds of the Salt-marsh: II.: Dr. Sarah M. Baker and Miss M. H. Bohling.—A Collection of Borneo Mosses made by the Rev. C. H. Binstead: H. N. Dixon.—Photographs of a Curiously-grown Tree from a Tunbridge Wells Garden: Rev. T. R. R. Stebbing.

FRIDAY, MAY 7.

ROYAL INSTITUTION, at 9.—Electrons and Heat: Prof. O. W. Richardson.

GEOLOGISTS' ASSOCIATION, at 8.—Radio-activity and the Measurement of Geological Time: A. Holmes.

SATURDAY, MAY 8.

ROYAL INSTITUTION, at 3.—Photo-Electricity: Prof. J. A. Fleming.

MONDAY, MAY 10.

ROYAL SOCIETY OF ARTS, at 8.—Foodstuffs: Dr. D. Sommerville.

TUESDAY, MAY 11.

ROYAL INSTITUTION, at 3.—The Animal Spirits: Prof. C. S. Sherrington.

ZOOLOGICAL SOCIETY, at 5.30.—The House-fly Campaign: Prof. H. Maxwell Lefroy.—Minchinia: A Haplosporidian: Mrs. Helen L. M. Pixell-Goodrich.—The Head Cavities and Development of the Eye Muscles in *Trichosurus vulpecula*, with Notes on some other Marsupials: Miss Elizabeth A. Fraser.—(1) The Organ of Jacobson and its Relations in the "Insectivora." II.: Talpa, Centetes, and Chyrsochloris; (2) The Anomodont Genera Pristerodon, and Tropidostoma: Dr. R. Broom.

SOCIETY OF ENGINEERS, at 7.30.—Some Future Developments in Heating and Ventilation: A. H. Barker.

WEDNESDAY, MAY 12.

ROYAL SOCIETY OF ARTS, at 8.—Recent Progress in Pyrometry: C. R. Darling.

INSTITUTE OF METALS, at 8.30.—The Passage of Electricity through Metals: Sir J. J. Thomson, O.M.

GEOLOGICAL SOCIETY, at 8.—*Parka decipiens*: Dr. G. Hickling and A. W. R. Don.

THURSDAY, MAY 13.

ROYAL SOCIETY, at 4.—Election of Fellows. At 4.30.—*Probable Papers*: The Development of the Thymus, Epithelial Bodies and Thyroid in the Vulpine Phalanger (*Trichosurus vulpecula*): Elizabeth A. Fraser and Prof. J. P. Hill.—Some Observations on the Development of the Thymus, Epithelial Bodies and Thyroid in Phascolarctos, Phascolomys and Perameles: Elizabeth A. Fraser.—Measurement of the Specific Heat of Steam at Atmospheric Pressure and 104·5° C., with a Preface by Prof. H. L. Callendar.—Thermal Properties of Carbonic Acid at Low Temperatures. II.: C. F. Jenkin and D. R. Pye.

ROYAL INSTITUTION, at 3.—The Movements and Activities of Plants: Prof. V. H. Blackman.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian Trade and the War: Sir C. H. Armstrong.

IRON AND STEEL INSTITUTE, at 10.30.—A Selection of: Diffusion of Carbon in Iron: F. W. Adams.—Supplementary Notes on the Forms in which Sulphides may exist in Steel Ingots. II.: Prof. J. O. Arnold and G. R. Bolsover.—Researches on Iron, Silicon and Carbon Alloys: G. Charpy and A. Cornu.—Corrosion of Iron in Aqueous Solutions of Inorganic Salts: Dr. J. A. Newton Friend and P. C. Barnet.—(1) Relative Corrodibilities of Gray Cast Iron and Steel; (2) Note on the Removal of Rust by means of Chemical Reagents: Dr. J. A. Newton Friend and C. W. Marshall.—Communication on the Heating of an Open-hearth Furnace by means of Tar: Dr. A. Greiner.—Sound Steel Ingots and Rails: Sir R. A. Hadfield and Dr. G. K. Burgess.—The Nature of the A_2 Transformation in Iron: K. Honda.—Brinell Hardness and Tenacity Factors of a series of Heat-treated Special Steels: Dr. A. McWilliam and E. J. Barnes.—Thermo-electric Properties of Special Steels: A. M. Portevin and E. L. Dupuy.—Stress-strain Loops for Steel in the Cyclic State: Dr. J. H. Smith and G. A. Wedgwood.—Detection of Burning in Steel, and Iron, Carbon, and Phosphorus: Dr. J. E. Stead.

FRIDAY, MAY 14.

ROYAL INSTITUTION, at 9.—The Archives of Westminster Abbey: Rev. E. H. Pearce.

IRON AND STEEL INSTITUTE, at 10.30.—A Selection of Papers mentioned above.

ROYAL ASTRONOMICAL SOCIETY, at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Distribution of Heat in the Cylinder of a Gas-engine: Prof. A. H. Gibson and W. J. Walker.

MALACOLOGICAL SOCIETY, at 8.—A Dibranchiate Cephalopod (Plesioteuthis) from the Lithographic Stone of Bavaria: G. C. Crick.—Description of a New Species of Zingis from British South West Africa: J. R. le B. Tomlin.—Diagnosis of a New Species of Dyakia: G. K. Gude.

SATURDAY, MAY 15.

ROYAL INSTITUTION, at 3.—Advances in the Study of Radio-active Bodies: Prof. F. Soddy.

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THURSDAY, MAY 13, 1915.

PHYSICAL CONSTANTS.

Société Française de Physique, Recueil de Constantes Physiques. By Prof. H. Abraham and Prof. P. Sacerdote. Pp. xvi+753. (Paris: Gauthier-Villars, 1913.) Price 50 francs.

THIS large and handsome volume of 753 pages is a collection of physical constants compiled under the auspices of the French Physical Society by Profs. Abraham and Sacerdote, and printed in the excellent style with which one is familiar in the publications of Messrs. Gauthier-Villars.

Following the custom of the more recent editions of Landolt and Börnstein's Tables and the new Annual International Tables of Constants, the work has been divided among a number of specialists, and each page bears the name of the individual responsible for it.

The system adopted has particular advantage in a volume planned with the idea of giving in general only one value for each constant. Reference is usually given to the name of the authority cited and the year of publication, but the source of the particular information is not specified. A useful explanatory paragraph with formulæ generally precedes each table.

A novelty is the introduction of a large number of curves. For example, the curves of the physical properties of gases given by Amagat impart at a glance an amount of information which would have required a table of many columns. Some very fine reproductions of spectra are given, including a large-scale reproduction of the iron spectrum, which should be extremely useful.

An examination of the book and frequent reference to it for constants required in actual work has revealed only few errors, and on the whole the work of the compilers appears to have been well done and the subject matter judiciously chosen.

Among the more interesting novelties are the useful sections devoted to wireless telegraphy and to physical measuring instruments, and no one could have been found to write with more authority on alloys than M. Le Chatelier.

Some eccentricities appear in the initial table on units; few physicists are familiar with such terms as "volume massique" and "masse volumique," "degré carré," and "steradian."

In the table of the specific heat of water the results of nine different observers are given, in most cases to four decimal places. But the "valeurs combinées" are given to *five* places, although examination of the individual values shows large discrepancies in the third decimal. It is much better to avoid in a case of this kind a fallacious air of precision, and it would have been wiser to have followed the example of Commandant Defforges, the well-known authority on pendulum observations, who told an eminent physicist with whom he was discussing his work:—

"Each year, as I know a little more of the difficulties, I suppress a decimal place in my results."

A good feature of the index of organic bodies is that in many cases the common name of a substance is given as well as its other names, perhaps only adopted by the chemists during a period of some passing fashion. For example, benzophenone is to be found in the index, as well as its synonyms, diphenylmethanone, diphenylketone, and benzoylbenzene. On the other hand, formaldehyde is *not* to be found, although four other names of this body appear in the index.

It is, however, surprising to find repeated the old familiar error, the confusion of benz*ine* and benz*ene*, words which in no language mean the same thing, although in some their pronunciation is unfortunately identical.

In some cases almost too much information is given. Thus, for example, the work of Tammann and his associates on the influence of pressure on the melting point of a large number of substances is quoted in detail, while practically nothing is to be found on the even more important effect of pressure on the boiling-point, excepting for a few organic bodies. For dp/dt for sulphur vapour is given Regnault's old value, 0·82° per mm., now known to be considerably too low.

Perusal of a work of this magnitude is suggestive in showing how great is our ignorance in many important branches of knowledge, where it might have been imagined much more precise and accurate data would have been to hand. A good example is the subject of thermal radiation, transparency, etc., where we still depend on Leslie, Rumford, Melloni, and other pioneer workers, who showed the way, where comparatively few have followed to repeat their work with modern appliances.

J. A. Harker.

THE PRESERVATION OF WILD LIFE IN AMERICA.

Wild Life Conservation in Theory and Practice. By Dr. W. T. Hornaday. Pp. vi+240. (New Haven: Yale University Press; London: Oxford University Press, 1914.) Price 6*s.* 6*d.* net.

NORTH AMERICA, when first opened up by Europeans, possessed a big-game fauna which, although poor in species, in point of numbers was equalled only by that of southern and central Africa; and it was likewise the home of an extensive and varied fauna of game and other edible birds. To this abundance of wild life is attributable the comparative facility with which the country was explored and settled; but no sooner was the settlement well advanced than ruthless slaughter led to the more or less complete extermination of some species, like the bison and the carrier-pigeon, and a vast reduction in the numbers of others, such as the prongbuck and bighorn. Fashion, sport, and other factors led, later on, to equal havoc among birds of many kinds.

Having permitted all this to come to pass, the country is now gradually waking up to the loss it has sustained, and to the remedial measures still possible in order to ensure the preservation of at least a remnant of the ancient superfluity of life. In this crusade Dr. Hornaday has for many years been a leader, and in the volume now before us he reviews what has been done and what still remains to be accomplished in a manner worthy of all commendation.

So urgent, however, is the case that the author calls upon all biological workers to abandon such comparatively unimportant matters as the description of species and races, the protective coloration of eggs, etc., and to devote all their energies to the cause of protecting and re-habilitating their country's fauna, not only as a food-supply, but, in the case of insectivorous birds, as a protection against the ravages of insect-foes, which are specially severe in America.

In his opening chapter—on the value of wild life—Dr. Hornaday enunciates the axiom that no species of wild land animal can long withstand systematic hunting for commercial purposes, as witness the destruction of the millions of the southern bison-herd within four years. He also points out that when a species has become reduced below a certain number it loses all recuperative power, and, like the heath-hen, fails to respond to protection. Instant action is, therefore, imperative in order to save the present remnant of the game-fauna, which is estimated to be only 2 per cent. of its former numbers. For this purpose "bag"-limitations have proved practically useless; and the conversion of national forests into reserves where shooting shall be absolutely prohibited, is a *sine qua non* (p. 49).

The period from 1885 to 1900 saw the great boom in the plumage-trade, to check which the Audubon Societies were organised; other agencies, which in many cases are proving victorious, came into action soon after; but the greatest hope for ultimate salvation is the federal law of 1913 for the protection of migratory species, which, by bringing recalcitrant States into line, saved the situation. Lastly came what it is hoped will prove the winning card in the shape of the Feather Bill.

R. L.

FOUR DIMENSIONS.

Geometry of Four Dimensions. By Prof. H. P. Manning. Pp. ix + 348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

PERHAPS the main interest of this work is that it treats the subject in a way that is comparatively new, and one that is likely enough to be generally adopted. Until quite recently, most works on hypergeometry might be roughly divided into three classes: popular or semi-popular outlines, which, however stimulating or suggestive, have little or no scientific value; frankly analytical disquisitions, such as those of Riemann, etc.; and works which, although couched in geometrical language, give the impression of being, so to speak, translations of previous analytical demonstrations. It must be admitted, of course, that some authors (such as Segre) have obtained new and valuable results for surfaces in three dimensions by considering them as sections of hyper-surfaces, and have pursued other four-dimensional researches in a way which has much more the aspect of being purely geometrical. But since it is a psychological fact that so far we have no true intuition of four-dimensional space, the inference seems to be that these authors have become so familiar with the analytical arguments underlying their theorems that they pass without an effort to the corresponding geometrical form of statement; much in the same way as dualisation of a projective theorem becomes almost mechanical after sufficient practice.

The method of the present work may be described as a logical induction based upon explicit geometrical axioms about strictly geometrical indefinables. The primary element is the point; the primary undefined relation is that of a point P being collinear with a given segment AB. From this the definition and properties of a straight line are deduced; thence we proceed to the definition of a triangle; and from this, with the help of Pasch's axiom (a line meeting one side of a triangle and another side produced meets the third side), we arrive at the definition and properties of the plane.

Assuming, now, that after reaching a plane field of points there is at least one point not belonging to that field, we can construct a tetrahedron, and, by arguments strictly analogous to those employed before, arrive at a three-dimensional space (S_3), which is determined by any four of its points which are not coplanar. There is no logical reason why we should not assume the existence of at least one point which does not belong to S_3; if we do so, we are able, by similar arguments, to show that there will be a space S_4, containing S_3, which is determined by any five of its points which are *independent;* that is to say, which do not belong to the same three-dimensional field.

The important thing to notice here is that the argument is of such a kind that it does not appeal to intuition at all. It is true that by drawing figures, or making models, we can provide images which help us to see that for an S_1, S_2, or S_3 our assumptions are not self-contradictory—or rather to give us an irrational conviction that things are so; for, of course, nothing but a formal proof can demonstrate the consistency or inconsistency of a set of formal propositions, such as we are ultimately dealing with here.

When the reader has reached this point, he will see that we can define and investigate a sequence of spaces:—

$$S_1, S_2, S_3, \ldots S_n, \ldots$$

(each being a field of points) on the assumption that when we have reached a space S_n there is at least one point which does not belong to it. A space S_n is determined by $(n+1)$ independent points; namely, such as do not belong to one and the same S_{n-1}.

The author does not go further than the S_4. After establishing its (logical) existence, he proceeds to discuss perpendicularity and angles; symmetry, order, and motion; hyper-surfaces and polyhedra; the theory of parallels; and that of volume-measurement. Finally, there is a chapter on the regular "polyhedroids" (hyperpolyhedra) in the S_4.

There are many interesting details and illustrations; we may refer to one of these, as it shows very well the way in which we are brought to a halt in trying to make actual images of things in the S_4. If, in an S_2, we draw a square, then a square on each of its sides, and finally a square on one of the outermost sides (so as to make a Latin cross) we can see how to fold the squares about common edges until they form the faces of a cube in our S_3. Suppose, now, that in our S_3 we draw a cube; then a cube on each of its faces; and finally a cube on one of the outermost faces of the last. If we could get this solid into an S_4, we could "fold" the eight cubes about adjacent faces so as to form the boundaries of a hypercube. Until we can "see" how to do this, we have no proper intuition of an S_4, such as we have of the lower spaces. G. B. M.

THREE BOTANICAL BOOKS.

(1) *Mikrographie des Holzes der auf Java vorkommenden Baumarten. Vierte Lieferung.* By Dr. J. W. Moll and H. H. Janssonius. Pp. 336. (Leiden: E. J. Brill, 1914.)

(2) *Practical Field Botany.* By A. R. Horwood. Pp. xv + 193. (London: C. Griffin and Co., Ltd., 1914.) Price 5*s.* net.

(3) *All About Leaves.* By the late F. G. Heath. Pp. ix + 228. (London: Williams and Norgate, 1914.) Price 4*s.* 6*d.* net.

(1) IN this, the fourth instalment of his work on the intimate structure of the wood of Javan trees, the author deals with the families Connaraceæ, Leguminosæ, Rosaceæ, Saxifrageæ, Hamamelideæ, and Rhizophoreæ. The Leguminosæ occupy more than half the volume. In this family 118 specimens were examined, representing forty-nine species and four varieties contained in twenty-six genera. Under the heading of each family is a list of the literature in chronological order, followed by an enumeration of the species and varieties examined by the author. A general review of the gross and minute anatomy of the family as represented by the forms studied is then given, and the bearing of the results on the generally accepted sub-division of the family is discussed. These are, in the main, in conformity with the sub-division based on floral structure, but it is worthy of note that in Rosaceæ the differences between the groups are greater than is usually the case in a single family, and suggest the recognition as distinct families of the Amygdalaceæ, Chrysobalanaceæ, and Pomaceæ. A key for determining the species by means of the wood-structure is also given. Then follows a detailed description of each species or variety; first the general topography, which is sometimes illustrated by figures, and then an elaborate description of the various elements—wood-vessels, libriform fibres, wood-parenchyma, medullary rays, etc. The account includes measurements and the behaviour of the various elements to reagents. It is to be regretted that the author did not include photomicrographic reproductions of his sections; the few figures which are given are poor and show no detail.

(2) The title of Mr. Horwood's book is somewhat misleading. The book contains much useful information on the practical study of plants in the field, but also much extraneous matter often set down in a loose and desultory manner. The impression formed by the reader is that the author is a man of great industry and some knowledge, but does not realise his limitations. The book, if judiciously pruned and edited, would make a useful little volume. The author's intention is

"to explain and set forth the principles by which the ecologist should be guided, and the apparatus and plan to be adopted to enable him or her to work upon sound and approved lines." But the directions or suggestions will often lead to bewilderment; for instance, the section on pp. 4–6, entitled "What to Study," contains a curious medley of suggestions from the study of the form and size of pollen-grains to the procuring of "fruits and berries of foliage" (*sic*) for decoration at Christmas. On the other hand, the same chapter contains a useful section on flower-photography. Chapter ii., on methods of collecting, preserving, mounting, and storing plants for herbaria, contains much that is helpful, though the student will find puzzling matter in the section on "the arrangement to be adopted in the herbarium"; among other things the author suggests the preparation of "a printed list of all the species published since the year 1895 when the 'Index Kewensis' and Durand's 'Appendix' brought things up to date," thus ignoring the three supplements of the "Index Kewensis" which carry us on to the end of 1910.

A great part of chapter iii., which has the tremendous title, "The necessity for encouraging the study of botany on ecological lines, by the popularisation of pure life-histories of plants, through nature study, museums, scientific societies, and other associations, and in the university," might well have been omitted; much of it consists of extracts from the addresses or writings of well-known botanists. The next chapter, on the study of the life-history of a plant, would have been more helpful if in the brief paragraphs on the various divisions, such, for instance, those on "plants and fungi and insect-pests" or "names of wild plants" reference had been given to a good standard work on the subject. The last chapter (v.), "An outline of plant formations," is the best; it includes a brief description of various plant-formations and lists of the species which occur in them.

(3) The little book on "leaves" contains eighty photographs, mostly of British wild plants, which on the whole are good. They were specially prepared for the work, but were not seen by the author owing to his death in 1913. The text is in the style with which readers of the late Francis George Heath's botanical works are familiar. One example must suffice. Of the seed we read, "A created organism of wonderful and infinite skill confronts our marvelling sense in the remotest confines of the great vegetable world—so that we cannot begin at the beginning because we cannot comprehend the beginning! Power—unquestionable—hovers, so to speak, undiscernible in the tiny seed."

OUR BOOKSHELF.

The Golden Bough. A Study in Magic and Religion. By Sir J. G. Frazer. Vol. xii. Bibliography and General Index. Pp. vii + 536. (London: Macmillan and Co., Ltd., 1915.) Price 20*s*. net.

No book has ever been written which contains so large a mass of facts as "The Golden Bough." Nor has any book had its data more thoroughly documented. The bibliography and index, forming the twelfth and final volume of the work, fill 536 octavo pages. The index, 392 pages, is fuller than the indices to the separate volumes. Every author knows the labour of cross-references; a simple instance here is "propitiation of vermin by farmers," involving three entries. There are cases of overdoing, a good fault in an index, *e.g.* "*Nat*, spirit, in Burma, ii. 46." "*Nat* superstition in Burma, ix. 90 n¹." "*Nats*, spirits in Burma, iii. 90; ix. 175 *sq.*; propitiation of, ix. 96." Here a distinction is actually drawn between a singular and a plural. Technical generic terms in foreign languages are, like botanical and zoological terms, etc., printed in italics. But why "Oschophoria," yet "*Aiora*," both Greek feasts; and "Farwardajan," yet "*Sada*," both Persian feasts; also "Ogboni" and "Belli-Paaro," African secret societies, yet "*Ndembo*" and "*Hametzes*," also secret societies? But these are minor inconsistencies in a monumental index.

The bibliography comprises probably six thousand books, including serial publications and dictionaries. The curious may find instructive items, *e.g.* Macletius (Maletius, Meletius, Mencius, Ian Malecki), who, by the way, wrote on the religion of the Borussians (the present-day Prussians). Many periodicals, *e.g.* *L'Année Sociologique* and *L'Anthropologie*, have not their year of institution, nor, what is far more important, their place of publication attached. How are "readers who desire to have further information," to find "*Fasciculi Malagenses, Anthropology*," or "Dinkard, a Pahlavi work"?

The distribution of anthropological research among the civilised nations may be well estimated from this bibliography. England, America, and Holland are prominent; Germany has done much, so has France. The native authorities on uncivilised peoples are an interesting addition.

A. E. CRAWLEY.

The Plateau Peoples of South America. By A. A. Adams. Pp. 134. (London: G. Routledge and Sons, Ltd., 1915.) Price 3*s*. 6*d*. net.

THE people discussed in this monograph are those inhabiting the South American plateau within the boundaries of Bolivia, Peru, and Ecuador. Bolivia, however, seems to be more closely associated with the past history of the plateau than either of the other republics. Its government is largely drawn from the plateau population, and its general culture is more clearly influenced by the plateau than that of Peru, which looks to Europe for light and guidance. The writer finds in this upland race a condition of progressive degeneration. The people who occupied the country in what may be called prehistoric times were skilled in stone-working, as is shown by the great megalithic ruins at Tiahuanaca, described by Sir Clements Markham in his book, "The Incas of Peru." Since the building of this city, geological changes seem to have been in action which caused the elevation of the plateau and the shrinkage of the body of water now known as Lake Titicaca.

These changes brought about the present conditions: a very dry atmosphere, with a small percentage of oxygen and a high range of temperature, inducing nervousness and mental instability, a lack of forethought and industry, an overweening contempt of foreigners, and a perfervid patriotism. Many physiological facts indicate this retrogression, resulting in administrative incapacity, and neglect of regularised education. The poorness of the food supply, ill-cooked potatoes and maize-flour cakes, promotes physical degeneration and leads to over-indulgence in stimulants. The writer takes, perhaps, too gloomy a view of a people whom he dislikes and despises, but he appears to write with adequate knowledge, and his monograph, if his conclusions be accepted, furnishes a good example of the action of an unfavourable environment upon a race exposed to its influence.

A Pilgrim's Scrip. By R. Campbell Thompson. Pp. xii + 345. (London: John Lane, 1914.) Price 12*s.* 6*d.* net.

These slight, discursive sketches of the life of a wandering archæologist in the Nearer East are interesting and instructive. The studied archaism of the style, a trick which may have been learned from Mr. Doughty's famous "Travels in Arabia Deserta," becomes, after a time, a little monotonous, but it gives a piquant flavour to his accounts of eastern life and character. The writer is one of the school of scholarly antiquaries, trained by the British Museum, who, in spite of many hardships and the necessity of making scanty funds go a very long way, have done noble service in adding to our national collections.

Mr. Campbell Thompson's experience has given him a considerable insight into the back of the oriental mind,and his hints for dealing with these races and conducting excavations will be serviceable to those who may follow his tracks. His wanderings have extended widely: Mosul, Behistun, the Sinaitic Peninsula, the Sudan, Angora, and Carchemish, are some of the stages. Perhaps the most interesting episode is his excursion, in company with Mr. L. W. King, to make a fresh copy of the famous inscription of Darius at Behistun, the riddle of which was solved by the genius of Sir H. Rawlinson. Swung from cables suspended over the precipice the explorers collated Rawlinson's copies, which proved to be wonderfully accurate, and succeeded in photographing, from a five-foot range, the splendid head of the warrior king—a fine piece of work told modestly and clearly.

The book is well illustrated by photographs and, which is unusual in popular works of travel, is provided with an excellent index.

Morale Fondée sur les Lois de la Nature. By M. Deshumbert. Cinquième et Sixième Mille. Pp. 191. (London: Watts and Co., n.d.)

The Comité International de Propagande pour la Pratique de la Morale fondée sur les Lois de la Nature has representatives in eighteen countries. Its Bureau Central is at Dewhurst, Dunheved Road West, Thornton Heath, England. It issues a propagandist volume on the subject of a natural morality, written by the secretary, M. Deshumbert, which has been translated into eight languages. Much has been written on morality "according to nature," since the Stoics invented the idea, but this book, partly because the author understands both physiology and biology, has a freshness of appeal. "Good is all that contributes to the conservation and increase of life . . ." by co-operation and mutual aid of individuals each of whom is thus aided towards complete self-realisation. Evil is all that diminishes life. The end of Nature is life and more life.

These and connected axioms are well illustrated by examples of anti-natural human superstition and of the importance in the animal world of intellectual and moral qualities. The way in which, *e.g.* the tiger depends for existence upon observation, judgment, patience, self-control, decision, and perseverance, is quite a fresh object-lesson. A collection of practical rules of personal hygiene and a detailed list of physiological functions are useful, and might form the nucleus of a modern scheme of individual morality. Some quotations from J. Payot are interesting here. A set of parallels between the intelligence of nature and of man is interesting, and might be augmented. "Man in many cases is inferior to nature," but this simply points the truth that man is part of nature.

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.*]

Ultra-Violet Excitation of the D Line of Sodium.

It is well known that the D line of sodium is the first member of a series of lines, the other members being in the ultra-violet region of the spectrum. It is known also from the investigations of R. W. Wood that sodium vapour at a moderate temperature illuminated by D light gives rise to a secondary emission of D light. This secondary emission is appropriately called by him resonance radiation. It has been further investigated by Dunoyer.

The first ultra-violet line of the series is situated at wave-length 3303. It is very probable for a number of reasons that this or any other line of the series would give rise to resonance radiation, though I do not know of any experiment directly establishing the fact.

A more doubtful question is whether stimulation by the line 3303 would give rise to D light. The question is not new. It has been proposed by Prof. Wood, and he has looked for the effect, but without success. The matter seemed important enough, however, to justify a fresh effort, and within the last few days I have been able to get the effect as satisfactorily as could be wished.

The chief essential is a source giving a sharp line of great intensity at λ 3303. This was found in a sodium vapour lamp in quartz analogous to the mercury lamps in general use. Details of the construction and manipulation of these sodium lamps will be published later. The visible light from such a lamp was filtered out by means of a screen consisting of cobalt-blue uviol glass, combined with nitrosodimethylaniline. The light which came through was photographed with a quartz spectrograph, and was found to consist of λ 3303 exclusively.

This radiation was concentrated by means of a quartz lens on a quartz bulb containing some sodium. The bulb was made nearly red-hot with a bunsen burner, which was then extinguished. A patch of luminosity could be seen on the wall of the bulb when the ultra-violet beam fell upon it. As the bulb cooled and the vapour pressure of the sodium diminished, this patch of light gradually expanded, and filled the entire bulb; it then faded away, and had disappeared when the bulb was cold. This behaviour is exactly the same as is seen when D light is excited by the incidence of D light, and although in the present case the light is much fainter, the conditions of observation are in some respects more favourable, for there is no disturbance from visible light scattered or reflected by the walls of the vessel.

Critics of this experiment will naturally concentrate their attention on two questions :—

(1) Was the light observed really due to ultra-violet excitation?

(2) Was it of the same wave-length as the D line?

As regards (1), a sheet of plate-glass 1·2 cm. thick was interposed between the source and the bulb. The excited light was completely extinguished.

As regards (2) the light was rather below the intensity which would easily allow of direct spectroscopic examination, though with a little further improvement of the conditions it might be made strong enough. I have, however, proved it to be of approximately this wave-length by absorption methods. The luminosity was seen undiminished through a thick cell containing potassium bichromate solution, held before the eyes. It was absolutely invisible through a cell containing praseodymium nitrate. Thus the wave-length must lie in the region from λ 5820 to λ 6020, for this is the only region transmitted by bichromate and absorbed by praseodymium. The D line at λ 5890 lies in this narrow region, and I think, therefore, that there is no reasonable doubt that the emission does consist of D light. Discussion of the theoretical bearing of this result is deferred.

R. J. STRUTT.

Imperial College, South Kensington, May 8.

The Green Flash.

MANY descriptions of the green flash have been published in letters to NATURE and elsewhere, but I do not remember to have seen a satisfactory explanation of this curious phenomenon. Atmospheric dispersion is invoked, but this does not explain the absence of the red end of the spectrum. My observations agree in every particular with those described by Mr. Whitmell in NATURE of March 11, p. 35. At sea I have observed a violet or blue tint occasionally, and on one occasion a red flash as the lower limb of the sun emerged from a cloud into a clear space very near the horizon.

Normal atmospheric dispersion will, of course, produce a red fringe to the sun's lower limb, and a blue fringe at the upper limb, as may be seen at any time with a telescope free from secondary colour when the sun is as high as ten or fifteen degrees above the horizon. When, however, a point of sunlight only is visible, the rest of the disc being hidden beneath the horizon, atmospheric dispersion, if it could be perceived with unaided vision, should produce a complete vertical spectrum from blue to red, as in the case of stars when near the horizon. The red end of this spectrum should be most evident, since these rays are least absorbed. In the flash, however, the red is completely suppressed, and the vivid green which is obvious to the naked eye can only be seen at very low horizons. Moreover, it is not always seen, as Mr. Whitmell remarks, when the conditions seem otherwise favourable.

It seems to me very probable that the phenomenon is in some way connected with the abnormal conditions which at sea produce mirage effects. The layer of dense air in contact with the sea might produce total reflection for solar rays refracted from below the horizon, but the critical angle of reflection will depend on wave-length, and it is possible under certain conditions that the green rays may be totally reflected whilst the red are refracted.

I have one more observation to add to those described by Mr. Whitmell, and this will, I think, give the *coup de grâce* to the theory of a subjective effect due to retinal fatigue. In May, 1900, I happened to observe the setting of Venus in the sea from my eclipse camp on the Algerian coast. Observing with a 3-in. inverting telescope, I saw the planet when very near the horizon suddenly change in colour from dull red to vivid green, and as I lowered the telescope to the point where the sea horizon about bisected the field of view I was amazed to see *two* green images of Venus, one, the normal image, ascending from below, and the other sloping down from above. This was probably reflected from the sea itself. The setting took place at the moment of meeting of these two images. The whole apparition, from the moment when the colour changed from red to green, to the instantaneous disappearance of the two images, cannot have lasted more than four or five seconds. The sea about this time was found to be excessively cold, although the air was hot during the daytime, and this state of things would doubtless favour the production of a relatively dense layer of air on the surface of the sea in calm weather.

JOHN EVERSHED.

Kodaikanal, April 13.

The Larger Ions in the Air.

IN addition to the well-known small ions, which are of a type common to all gases, two classes of larger ions exist in the air under ordinary conditions. One of these consists of the large ions of Langevin which have a mobility of about 1/3000, while the other contains ions with a mobility of about 1/50. As the latter value lies between those of the mobilities of the small and large ions, the members of this latter class may be called the ions of intermediate mobility, or, shortly, the intermediate ions.

The slow movement of these larger ions in an electric field clearly indicates that they are molecular clusters of more or less complexity. Ordinarily the value of the mobility is the only guide to the nature of the ionic structure, but in the case of the large ion, at least, an important deduction is to be made from the outcome of experiments on the formation of clouds in closed vessels.

It is well known, since Aitken's notable work on the subject, that, in ordinary circumstances, the air is crowded with particles, in suspension, on which the water vapour condenses into visible drops if the air becomes slightly supersaturated. These particles, the number of which varies greatly from time to time, can be removed by filtration of the air through cotton-wool, or, in closed vessels, by settlement with the drops formed by expansions. In general, these nuclei are electrically uncharged, and whatever their nature, are conveniently known as dust particles.

C. T. R. Wilson has shown that in air recently freed from dust, with increasing supersaturations, the first visible condensation takes place on the small ions. It is now known that the circumstances of the condensation remain unchanged during intervals of time extending to days after the removal of the dust. The intermediate and large ions are eminently suitable nuclei for the condensation of water vapour, as their mobilities are largely affected by changes in the hygrometric condition of the air, so the results just mentioned indicate not only that these ions are removed with dust particles, but also that they are not produced in air once made dust-free. There is no doubt that the large ions are present in ordinary saturated air; it appears, then, that filtration removes some rigid nucleus without which at least the large ion cannot be developed.

From the facts which have been stated, the picture of the large ion most readily formed is that of a dust particle round which water molecules are adsorbed to an extent depending on the vapour pressure, the whole being electrified by the attachment of a small ion.

Some idea of the nature of the relation between mobility and vapour pressure which is to be expected in connection with such an ion, may be obtained by comparing, on simple thermodynamic lines, the working of two Carnot's engines, one with unit mass of a mixture of ions and water vapour as the working substance, and the other with unit mass of water and its vapour. The vapours are to be taken as perfect gases, and it is to be assumed that the density of a vapour is small compared with that of the substance in the corresponding denser state. With these assumptions the result is readily obtained that $(p_1/p_2)m = (P_1/P_2)^{1/n}$, when only the change of state is being considered. p and P are the values of the vapour pressures in the two engines at the same temperature, and n is the ratio of the latent heat of vaporisation of water to that of the fluid surrounding the nucleus of the ions. It is convenient here to take m as the mass of the denser part of the substance. The expression, which holds for all cases of adsorption, states that at two temperatures the mass adsorbed will be the same if the ratio of the vapour pressures, in equilibrium with the adsorbed fluid, is the nth root of the ratio of the saturated vapour pressures at those temperatures. It is the formula of reduction for adsorption observations taken at different temperatures, and a clue to the condition of the adsorbed moisture is to be obtained from the value of n found necessary to make the observations fall into line. As the mobility of the ions under consideration, at constant temperature and air pressure, is constant if the mass of the adsorbed fluid remains the same, the formula is directly applicable to mobility determinations if m is taken to refer to the mobility reduced to constant air density.

Trouton, and Masson and Richards, find that the mass of contained moisture in the case of flannel and cotton-wool is a function of the relative humidity. This means that n is unity in the preceding expression. n is also unmistakably unity in connection with the large ion, the determinations of mobility only falling into line if plotted against the relative humidities. The result of such a plot is shown in Fig. 1.

No heat change due to a variation of surface energy is involved in the value of n, so in these cases where $n=1$, as the heat per unit mass necessary to annul a temperature change due to the mere alteration of state is the same as that required to keep the temperature constant when water evaporates, it may be definitely concluded that the molecules in the contained or adsorbed fluid are in the same condition of aggregation as those of water.

In the case of the intermediate ions the determinations of mobility are not accordant enough to allow the value of n to be found in this way with any accuracy, but the fit of the points to a line is on the whole better if the mobilities are plotted against vapour pressures than when set out against the relative humidities. This, according to the preceding expression, corresponds to the physically extreme case when n is equal to some large number, though, so far as could be inferred from the plot, n might not be greater than some small integer. In any case, here the latent heat of vaporisation of water is sometimes greater than that of the adsorbed fluid.

The result of the preceding line of argument, though not conclusive in the present instance, at least suggests the idea that the intermediate ion consists of a rigid core enveloped by a collection of water molecules existing as a dense vapour rather than in the liquid condition.

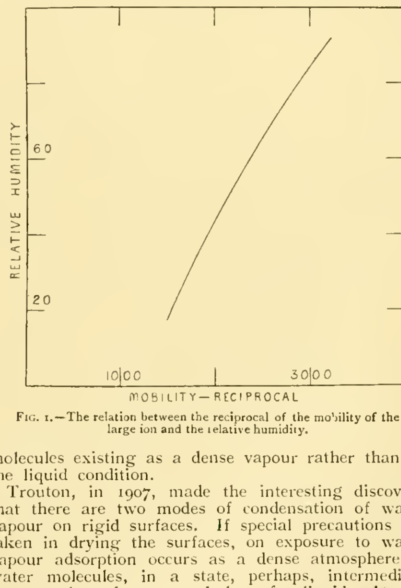

FIG. 1.—The relation between the reciprocal of the mobility of the large ion and the relative humidity.

Trouton, in 1907, made the interesting discovery that there are two modes of condensation of water vapour on rigid surfaces. If special precautions are taken in drying the surfaces, on exposure to water vapour adsorption occurs as a dense atmosphere of water molecules, in a state, perhaps, intermediate between that of a gas and that of a liquid. At any rate, a change to the liquid condition somewhat abruptly takes place in these circumstances when, according to Trouton, the humidity is about 50 per cent. in the case of glass, and about 90 per cent. in that of shellac.

The fluid surrounding the nucleus of the intermediate ion is, no doubt, in a state corresponding to that of the moisture condensed at low pressures on carefully dried surfaces in Trouton's experiments.

Further evidence supports the preceding view of the ion. Fig. 2 shows the relation between the reciprocal of the mobility of the intermediate ion and the vapour pressure as deduced from a plot of the determinations. At a pressure of about fifteen millimetres the mobility decreases very rapidly with increase in the value of the vapour pressure. Simultaneous observations of the intermediate and large ions were obtained on many occasions, but with vapour pressures exceeding seventeen millimetres, while the observations of the large ion were equally good, all trace of the intermediate ion disappeared.[1] Disintegration of the ion at a critical vapour pressure is unlikely, and it is much more probable, assuming a rigid nucleus, that the adsorbed fluid is in the condition of a dense vapour, and that at the critical pressure it changes its state to that of a liquid, like the moisture adsorbed by glass and shellac in Trouton's experience.

Such a change means a decrease in the energy of the aggregation, and is to be expected when the molecules of water vapour around the nucleus become sufficiently closely packed. The advent of a liquid surface involves a diminished rate of molecular escape; rapid condensation will therefore occur, with a decreasing unit-surface energy, until further increase in the size of the ion means an increase in the total energy of the mixture of ions and vapour. The final result is no other than the large ion. The assumption of a rigid core for the intermediate ion appears, thus, to be justified.

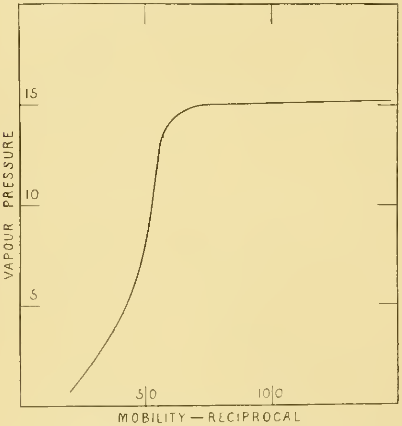

FIG. 2.—The relation between the reciprocal of the mobility of the intermediate ion and the vapour pressure.

To sum up the whole evidence, the large ion consists of a rigid nucleus surrounded by moisture in the liquid condition, the size of the drop at constant temperature depending on the vapour pressure. The intermediate ion is to be considered as a similar nucleus enveloped by a dense atmosphere of water vapour. The mass of the ion increases with the vapour pressure, until at a critical pressure the adsorbed fluid assumes the liquid state, and the aggregation develops, by the rapid condensation which ensues into the large ion of Langevin.

It is not quite clear how the electrical energy of the ions is related to their diameter. The charge is, however, not essential to the equilibrium of molecular structures such as those just mentioned, and it is not unlikely that the conclusions as to the nature of the ions, only rendered possible by the happy chance of their electrification, may apply with, perhaps, little modification to the far more numerous class of unelectrified nuclei which exists in ordinary air.

University of Sydney. J. A. POLLOCK.

[1] Details of these observations will be found in two papers published in the *Philosophical Magazine* for April and May, 1915.

Similitude in Periodic Motion.

IT may interest those of your readers whose attention has been direction to periodic motion to know that by reducing extremely large and extremely small frequencies to a musical base, and employing the middle C (256) as a standard the following results are obtained:—

Green light (frequency $5{\cdot}6\times10^{14}$) corresponds to the note C in the forty-first octave above the standard.

The colours—orange, green, and violet—roughly correspond to the musical chord ACE.

Human heart-beats (seventy-five a minute) correspond to the note E (320) in the eighth octave below the standard.

The earth's daily rotation corresponds to the note G (384) in the twenty-fifth octave below the standard.

Neptune's sidereal period almost corresponds with E flat (422) in the forty-first octave below the standard. HERBERT CHATLEY.

Tangshan Engineering College, Tangshan, North China, March 17.

A Simple Direct Method for the Radius Curvature of Spherical Surfaces.

THE following device was developed to obtain the radius of curvature of some lens surfaces that were too small for the available spherometers. It has proved so satisfactory that, not finding it in any of our

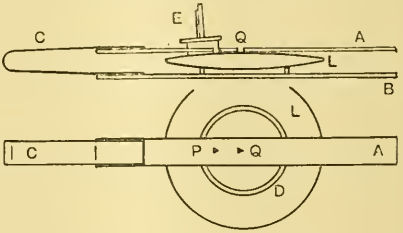

FIG. 1.

laboratory manuals, it has been thought to be of possible interest to others.

Two brass strips, A and B (Fig. 1), are connected by a flat spring, C. To B is soldered a brass ring, D, to serve as a bed for the lens, L, the surface of which is to be examined. A is pierced with two triangular holes, P and Q, as indicated in the sketch, the forward one having its vertex over the centre of the ring. A three-legged optical lever, E, is set with its legs on the glass surface, the front leg being as far forward as possible in one of the triangular holes, P (as shown). The other legs straddle the strip A, one being in contact with A. The lever E is not shown in the lower sketch.

If the mirror be lifted from its position in P to a similar one in which the front leg is at the vertex of Q, it will have been given a linear displacement (s) and an angular displacement (θ). The former of these quantities is the same as the distance between the vertices of P and Q. It is a constant of the instrument, and may be determined by means of a travelling microscope. The angular displacement (θ) depends on the lens surface, and may be obtained by telescope and scale in the usual way. The radius of curvature is then written by $\rho=s/\theta$.

The vertex of Q is placed over the centre of the ring, as this is the simplest way to ensure that the displacement lies along a great circle of the surface.

WILL C. BAKER.

Physical Laboratory, Queen's University, Kingston, Ont., April 19.

HOUSE-FLIES AS CARRIERS OF DISEASE.

THE discovery of the rôle of insects in the transmission of human and animal diseases is one of the most striking achievements of medical science during the last twenty-five years. Filariasis, Texas fever, nagana, malaria, sleeping sickness, yellow fever, dengue, sandfly fever, relapsing fever, plague, typhus, and many other diseases of the lower animals, have been shown to be transmissible by blood-sucking insects—mosquitoes, ticks, tsetse flies, fleas, or lice, as the case may be. The pioneers in this line of inquiry were Manson, Smith and Kilborne, Bruce and Ross.

In a number of cases the necessity of intervention by an insect has been established by the discovery that a portion of the life cycle of the parasite is passed in mosquito, tick, or tsetse fly respectively. In other cases, the evidence rests upon the correspondence in time and space of the incidence of the disease with the presence of some particular insect which has been experimentally shown capable of transmitting the infection. In yet other cases, such as plague, the microbe can also pass directly from patient to patient, as happens in the pneumonic variety of the disease, but the paramount importance of flea transmission in bubonic plague gains in recognition daily.

The rich harvest of discovery reaped by the investigations into the part played by blood-sucking insects in the spread of the above-mentioned diseases naturally stimulated inquiry into the possibilities of insect carriage as a factor in outbreaks of cholera, typhoid, dysentery, and epidemic diarrhœa. These are not diseases in the transmission of which a blood-sucking insect is likely to play a part, for in none of them is the infecting microbe present in the blood-stream in sufficient quantity, but the dejecta, fæces, and often urine, contain the bacilli in countless numbers. A small proportion of convalescents continue to excrete them for weeks, months, and, in the case of typhoid, for years afterwards, although enjoying perfect health. These people are particularly dangerous to the community as they form an unsuspected reservoir of infection.

To produce an epidemic of typhoid, cholera, or dysentery, the bacilli dejected by persons sick or convalescent from the disease must find access to the alimentary tract of others. There are, however, ways in which this may happen independent of the agency of insects. A water supply may become contaminated with infected material; the dejecta may dry up and be distributed as dust, and fall upon food materials (a method, the importance of which may easily be exaggerated, as these bacilli are readily killed by desiccation), or, owing to bacteriologically inadequate attention to cleanliness, food-stuffs, in which the microbes can multiply, may be infected with bacilli from patients or convalescents. Typhoid and cholera bacilli are small objects, less than one-thousandth of an inch in length, so that fingers may be easily soiled by considerable numbers without this being obvious, and the microbes are not removed by perfunctory washing.

Although these three means of spread do produce and maintain epidemics, one has but to consider the habits of the house-fly to realise that this insect may be an able and willing assistant in the distribution of the bacilli which are the cause of cholera, typhoid, dysentery, and diarrhœa, and that flies, if in sufficient numbers, and under conditions favourable for their operations, may constitute the principal way in which infection is distributed. In order to appreciate how this may happen it is necessary to be in possession of some few points in the life-history and structure of the fly.

These subjects have been submitted to careful inquiry during the last few years, particularly in America and this country, by Newstead, Howard, Griffith, Hewitt, and Graham Smith, and we are now well acquainted with this insect, intimate knowledge of which was, until recently, curiously lacking.

The female fly lays about 120 eggs at each laying, and may produce four broods. The eggs are mostly laid on horse manure or other fermenting refuse; they are about 1·5 mm. in length and 0·3 in their greatest diameter, and hatch in from three days to eight hours, according as the temperature ranges from 50° F. to 80° F. The larva is a little active grub 2 mm. long; and on hatching out burrows into the manure or other material on which the eggs are laid. The larval stage lasts five days to three weeks, and pupation five days to a month, according to temperature. Thus the whole cycle from laying of the egg to emergence of the fly occupies ten days to two months, according as the weather be warm or cold. The young female is ready to lay its first batch of eggs in about ten days, or even sooner in warm weather. Owing to this influence of temperature upon the rate of development of egg, larva, pupa, and imago, the number of flies in August depends on the temperature during June and July.

During winter a few flies survive in warm and secluded places. In the spring these start the next year's supply. Dr. Howard, of the United States Department of Agriculture, estimates that in forty days the descendants of one fly might number twelve million, or 800 lb. weight.

It will therefore be obvious that any attempt to overcome the nuisance from flies must, if success is to be achieved, be directed to their breeding haunts, and as early in the season as possible.

The points in the anatomy of the fly of importance for our present object are the legs and feet and the alimentary apparatus. These will be sufficiently obvious from the diagrams (Figs. 1 and 2). The feet are covered with minute hairs, which are more numerous and finer than in the diagram, and extremely fine hairs are also placed upon the pads. A sticky substance is secreted by the surface of the pads, by means of which the fly grips. Each leg is like a minute paint brush, which is applied to the surface of whatever it rests upon, excrement or food-stuff, as opportunity offers.

The alimentary canal comprises a gullet, stomach, crop, intestine, and rectum (see Fig. 2). The gullet is prolonged forwards to a minute opening between the flaps of the proboscis, halfway down which it is joined by the salivary duct (S D). At the entrance to the stomach (S) it is bifurcated, and one limb of the bifurcation is extended backwards to the bilobed crop (C). By a valvular apparatus at the entrance to the stomach, the insect can direct the liquid driven by the pump in its trunk into either the stomach or crop. The proboscis is a highly elastic muscular organ with universal movement. At the end are two flaps

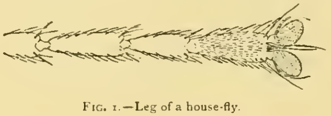

FIG. 1.—Leg of a house-fly.

or labella (only one of which is shown), which it can open out like the leaves of a book, and apply the medial surfaces to the material it feeds upon. From the middle line or hinge, minute chitinous channels pass outwards to the margin. At the base of the trunk a number of muscle fibres are attached to the gullet by the peristaltic contraction of which fluid is pumped up from the mouth and propelled into the stomach or crop. The structural arrangement of the channelled flaps of the trunk acts as a filter, through which solid objects larger than 1/4000th in. seldom pass. When feeding on a liquid, the fly applies the labella to the surface, and sucks the liquid through the

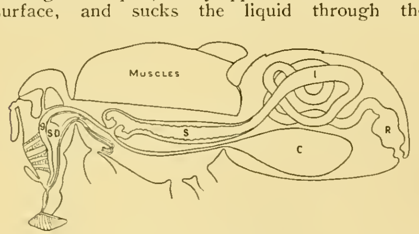

FIG. 2.—Alimentary system of a house-fly.

"strainer" first of all into the crop. When this is full, a further quantity is admitted into the stomach. In the case of solid material, such as sugar, the insect must first dissolve the material. This is done by pouring saliva upon it, or by regurgitating some of the contents of the crop.

A well-fed fly deposits fæces abundantly, and also the contents of its crop upon sugar and other solid objects.

It is clear, therefore, that there are *a priori* reasons for suspecting the fly of carrying bacterial infection. Born in a dunghill, it spends its days flitting between the sugar basin, milk pan, and any fæcal matter available. Its hairy, probably sticky, feet and the habit of regurgitating the contents of the crop and defæcating at frequent intervals, suggest it as an excellent inoculating agent for any bacteria it may pick up in the satisfaction of its catholic tastes. That it does, indeed, operate in this way has been abundantly demonstrated. Flies which have wandered over cultures of organisms and afterwards been allowed to walk upon gelatin plates leave a rich crop of germs in their footprints, which can be demonstrated by subsequent incubation.

Flies fed in the laboratory upon material containing easily identifiable pathogenic microbes have been shown to harbour them in their crops for days, and to deposit them in their fæces and the regurgitations from their crops. Internal carriage is probably more important than soiling of the exterior of the insect, as many pathogenic bacteria soon die from desiccation on the appendages of the insect.

In addition to these laboratory experiments, there are numerous recorded instances in which the pathogenic organisms of cholera, typhoid, phthisis, anthrax, and plague have been recovered from the interior or dejections of flies which have been captured in the immediate neighbourhood of cases of the disease, or, in the last two cases, of carcases of animals dead of the disease.

Although, however, flies may be discovered with the infection of a number of diseases in or upon them, and by their habits may not unlikely serve as agents in transferring infection, it by no means follows that they are the determining factor of epidemicity in the case of cholera, typhoid, dysentery, etc. In the case of fulminating epidemics of typhoid and cholera associated with an infected water supply, this is obviously not so.

It is in temporary encampments of troops or pilgrims, when the disposal of excreta must necessarily be of a primitive character, that the conditions obtain which are most favourable to the breeding of flies and the distribution of infection by them, if cholera or typhoid appear. Even in these circumstances it is difficult to assess the relative importance of fly carriage and other means of spread, but the conclusion that fly transmission is the principal means of spread of typhoid in military encampments and stations has been arrived at by a number of competent observers, amongst them the commission to inquire into the origin and spread of typhoid fever in the United States military camps during the Spanish war of 1898, and by a number of medical officers concerned with the severe outbreaks of enteric which occurred during the Boer war.

The sanitary arrangements of a military camp are not exactly those of the Ritz Hotel, and the prevalence of flies in late summer can scarcely be appreciated by those who have not had camp experience. The conditions are most favourable for transmission of disease by flies, and the circumstantial evidence against them is so strong as to have left no doubt in the minds of the American Commission that these insects play a large part in disseminating infection, for on page 28 of their general statement and conclusions we read:

"Flies undoubtedly served as carriers of infection."

An estimate of the fly population and its relation to admissions for enteric fever was made by Ainsworth in Poona, where enteric has a very definite season. A definite number of fly traps was set, and the daily catch taken as a measure of the fly population. The observations showed that the abundance of flies increased earlier than the admissions for enteric, and, speaking generally, the rise in fly population ante-dated the rise in enteric cases by about one month.

Taking into account the incubation period for the disease, this fact is in agreement with the view of a causal relation between cases and flies in Poona.

In considering the possible influence of flies in the spread of typhoid in a well-sewered city, it must be remembered that the opportunities for them to pick up the infection are vastly fewer than under the conditions of a military encampment, or even in rural surroundings. In large cities with modern sewerage, dejecta and urine from patients may be left available to flies, but the bulk goes promptly into the main drain, and similar observations to those above-mentioned have shown no close relationship, in point of time, between cases of typhoid and prevalence of flies in London, Washington, or Manchester.

As with typhoid, the case against flies as agents in the distribution of the infection of cholera is circumstantial, as other means of spread cannot be excluded. Take, for instance, the case of an accumulation of 300,000 pilgrims in Puri, India, in July, 1912, which was studied by Greig. The sanitary accommodation of the town was inadequate for such an accession to the population. Some of the pilgrims imported the infection of cholera, and an outbreak occurred. Flies in Puri "amounted almost to a plague," and a bacteriological examination of the legs and the contents of the alimentary tracts of flies caught in the neighbourhood of cholera cases demonstrated the presence of cholera vibrios.

Knowing the habits of flies, it is impossible to forgo the conclusion, arrived at by Greig, that some amount of distribution of the infection of cholera was due to their activity. But to what extent they were contributing could only be ascertained by the result of measures directed either to the diminution of their numbers, or to depriving them of access to infectious material.

Greig could not supervise the private latrines of the native inhabitants, but was able to carry out practical measures to prevent flies from visiting dejecta in the case of an outbreak of cholera amongst a limited population in the Puri jail. These were attended with immediate good results.

There are the same general reasons for assuming that fly transmission plays an important part in epidemics of summer diarrhœa of infants as in the case of typhoid and cholera. Anyone familiar with the domestic *ménage* of the average working man on a hot summer day, with the baby sick with diarrhœa, and other small children to care for, must realise that the opportunities afforded for flies to transport the infective agent from the dejecta of one child to the food supply of another are more than adequate.

Epidemic diarrhœa of children does not occur except during that season of the year when flies are abundant and active, and, as will be seen from the accompanying chart, the relation between fly population and diarrhœa cases is so

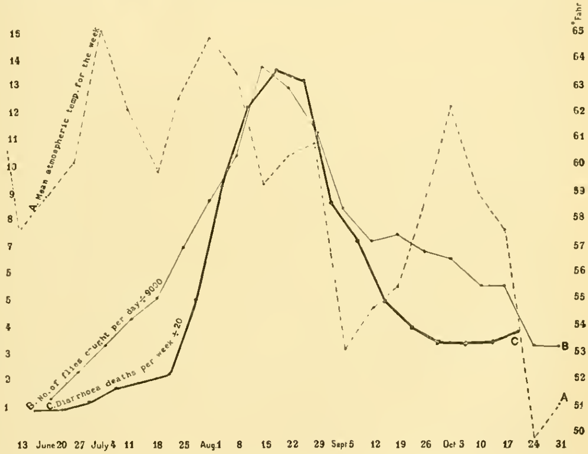

FIG. 3.—Dr. Hamer's observations on relation in point of time between prevalence of flies and diarrhœa mortality in London, 1908. (141 fly-collecting centres.) The deaths from diarrhœa have been antedated 10 days

striking as to suggest something more than a mere accidental dependence upon the same phenomena.

The chart is constructed from Dr. Hamer's observations on the numbers of flies caught daily in the same number of traps in 141 localities in London during 1908. An important point brought out by these observations is the dependence of both the number of flies and the epidemic upon the cumulative effect of previous warm weather—as, for instance, is indicated by the earth temperature four feet below the surface, a fact to which attention was directed by Ballard in 1889. Similar observations in Manchester, by Dr. Niven, in 1904 to 1906, showed the same relationship.

The reason why the number of flies should be dependent upon this factor is obviously that the generation time (cycle from egg to egg) is dependent on temperature, and requires three weeks or upwards in our climate. Months of warm weather are therefore required to produce any multitude of flies from the few surviving in the winter. Why the epidemic should exhibit this dependence is not explained, unless on the assumption that the fly population determines the number of cases of diarrhœa.

Without losing sight of the various other ways in which the specific infective agents of cholera, typhoid, epidemic diarrhœa, and dysenteries may be and are transported from the excreta of one individual to the mouths of others, the *prima facie* case against the house-fly is complete.

Further, in the case of infantile diarrhœa, the fly-carriage hypothesis offers a satisfactory interpretation of the extraordinary dependence of the epidemic upon the accumulated effect of temperature, and affords a ready explanation of the spread of the infection of cholera, typhoid, and diarrhœa to neighbouring persons who have no contact with the patient, in those cases in which contamination of a water or food supply may be excluded.

The direct proof of the extent of the danger due to flies is lacking, but the hypothesis has pragmatic value. It not only interprets facts otherwise awkwardly explained, but measures based upon it have been attended with beneficial results; in other words, it works.

THE RESURRECTION OF BABYLON.[1]

THOUGH scarcely a book to attract the general reader, Dr. Koldewey's account of the German excavations on the mounds which have for ages entombed the remains of Babylon the Great, is a work of considerable importance for all who are interested in the archæology of the Old Testament. This, as perhaps is not generally known in England, is still a growing science; and the worst thing that can be said of the German Expedition to Babylonia is that, after so many years of patient and persistent spadework on one of the most promising sites in the world, it has not yet succeeded in unearthing anything of higher historical or religious value than is recorded in the volume before us. Nothing extraordinary has hitherto been found; no great literary monument, no document of supreme religious moment, nothing that lends decisive help towards the settlement of any one of the unsolved problems of history or chronology. How much more fortunate in this respect were the pioneering labours of Layard and George Smith and Botta at Nineveh, of Rassam at Sippara, of De Sarzec at Tellô, of De Morgan and Scheil at Susa!

It is well for us that the Assyrian kings were so deeply interested in the literary monuments of Babylon. Had we depended for our knowledge of these on the remains of the Great City itself, we should (until the recent American discoveries at Nippur) have been left without any indication of the existence of the Babylonian legends of Creation and the Deluge; to say nothing of the many relics of the arts and sciences of Babylon which the library of Assurbanipal preserved for us.

The pathos of the position of the German explorers was that the site had been looted so often previously to their systematic investigations that scarcely anything of first-rate importance was left for the latest adventurers. The temples and palaces of Nebuchadrezzar's capital were probably swept bare of most of their portable treasures at a comparatively early period; and the ravages of people in search of building material, and the petty pilferings of Arabs and other stray visitors, had doubtless robbed the ruins of much that would have been priceless in the eyes of modern explorers. Even the beautiful enamelled bricks,

FIG. 1.—Enamelled wall length of the Ishtar Gate. From "The Excavations at Babylon."

with their strange mythological figures, are not altogether a novelty. Older specimens of the same kind of mural decoration were long ago reproduced by Perrot and Chipiez from Sargon's palace at Khorsabad ("History of Art in Chaldea and Assyria," II., plate xv.; see also plates xiii–xiv. Eng. Trans., London, 1884). But it is highly satisfactory to find such splendid examples as those of the Ishtar Gate still existing, *in situ*, and in such an excellent state of preservation (Fig. 1).

Whether anything of supreme value awaits disinterment at lower levels remains to be seen. Slabs of diorite or other hard stone, like the famous stela of Hammurabi, or the similarly written inscription of Nebuchadrezzar, which is (or was) one of the treasures of the library of the

[1] "The Excavations at Babylon." By R. Koldewey. Translated by Agnes S. Johns. Pp. xix+335. (London: Macmillan and Co., Ltd., 1914.) Price 21*s*. net.

East India House, might well have survived an age-long immersion in Euphratean mud. In any case, disappointing as, in such respects, results have hitherto proved to be, we entirely agree with Dr. Koldewey that it is most desirable that the work of excavating this historic site, begun so many years ago, should be carried to completion. Meanwhile, the special student will not fail to find many good things in this storehouse of facts and comments. It is now certain that ancient accounts greatly exaggerated the extent of ground actually covered by the city, the influence of which dominated the civilised world from the age of Hammurabi, the founder of its imperial greatness, to that of Nebuchadrezzar, who, if he did not find it of brick and leave it of marble, undoubtedly restored and enlarged its walls and temples and palaces on so grand a scale that the glories of Babylon the Great became a standing wonder of antiquity. The walls, however, have been found to range from upwards of fifty to more than sixty feet in thickness, and the mounds which concealed them rose to about four times the height of the ordinary *Tels* of buried Oriental cities: circumstances which sufficiently indicate the arduous nature of the task of excavation.

Dr. Koldewey's translations are, for the most part, good and accurate; but in EIH. VI. (not "7") 22–55, the passage in which Nebuchadrezzar or his court historian describes the building of the new eastern wall and the making of the moat, either he or his translator has misunderstood Winckler (KB., iii., 2, p. 23), who explains *IV M amat gagari*, "4000 cubits of ground," as referring to the length of the new wall, not to the distance from Imgur-Bel, and renders *itâti Bâbili nisis lâ dahê*, "an den Seiten von Babylon, in der Ferne, sodass sie nicht herankam," where "sie" also refers to the new wall.

We must also be excused if we demur to the transcription "Sirrush" and the explanation "a walking serpent" (p. 46). The çirrush, or rather, mush-rush, was one of the aqueous monsters created by Tiâmat, to help her in warring down the gods of light. It is something to learn what a MUSH-RUSH was like; and Dr. Koldewey has enabled us to identify it with a form already

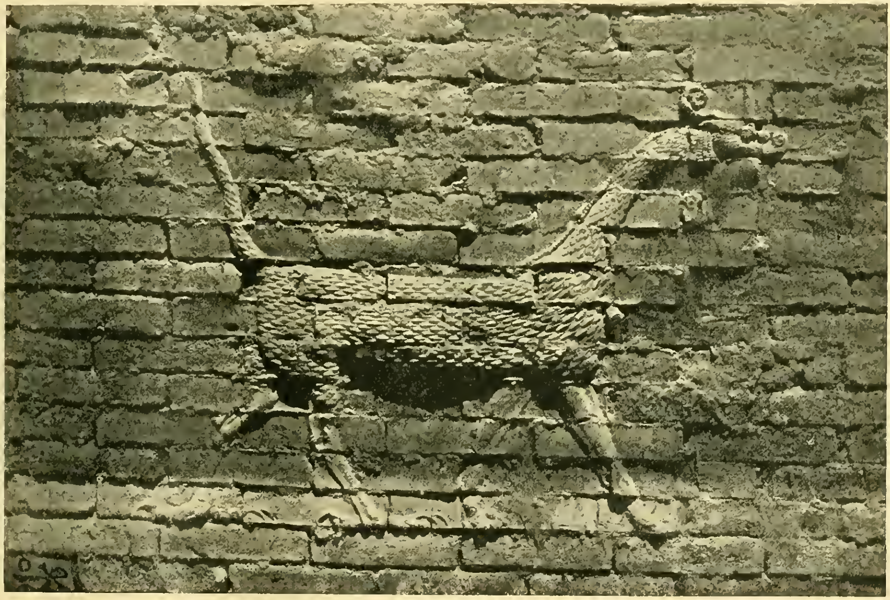

FIG. 2.—A Sirrush. From "The Excavations at Babylon."

familiar to us from other Babylonian monuments. It was, in fact, not so much a serpent (though the Sumerian MUSH includes that meaning) as a composite form with serpent head, scales, and tail, and four claw-footed legs—a sort of "laidly worm" or "fearsome dragon," and remarkably like a dinosaurus. The name may denote *fierce* (or *glittering*) *dragon* (Fig. 2).

Dr. Koldewey first visited Babylon in June, 1887, about the time when the present reviewer was working upon the text of the East India House inscription of Nebuchadrezzar (see Proceedings of the Society of Biblical Archæology, December, 1887). What a godsend would the present volume have been in those days, clearing up as it does by its thorough investigation of local conditions and the actual remains of the ancient buildings so many of the earlier translators' almost hopeless perplexities! One after another, the Procession Street of Merodach, the Sacred Way along which marched the annual solemnity of Babylon's tutelary god; E-MAGH, the temple of NIN-MAGH, "The Exalted Lady," several inscribed cylinders from which may be seen in the British Museum collection; the Gate of Nanâ-Ishtar, with its superb enamelled figures; the palace of Nabopolassar (Nabû-apla-uçur), which Nebuchadrezzar restored with great splendour; the location of E-SAG-ILA, the temple of Merodach, and chief sanctuary of Babylon; the world-famed walls, and various connected structures, were determined and in part exposed to view.

All this, though perhaps not exactly the kind of matter to stimulate the enthusiasm of one who reads merely to while away an idle hour, constitutes a highly important contribution towards an exact topography of Babylon, and to the right understanding of the inscriptions of the Neo-Babylonian period; while it enables classical students to bring to the test of ascertained facts the descriptions of Babylon which we find in Herodotus and subsequent Greek and Latin authors, extracts from whose pages are given in Koldewey's convenient appendix. It is to be hoped that current events in the East may prove no bar to the further prosecution of Dr. Koldewey's meritorious and, indeed, necessary enterprise—even if it happen by the fortune of war that the whole or part of the treasures recovered by his continued labours should find their way to London instead of Berlin.

It should be added that the author has been fortunate in his translator, the English of the book being generally accurate and readable—which is not always the case with translations from German originals.

C. J. BALL.

SCIENCE AND INVENTION.[1]

(1) MR. EDELMAN'S book commences with descriptions of a number of scientific experiments, illustrated by small but clear diagrams. Some of these experiments will be familiar to all those who have taken an experimental course in chemistry and physics, but freshness is given by including simple instances of technical applications of scientific principles. Thus, sections are devoted to "thermit," the electrolytic cleaning of tarnished silver by contact with aluminium in a solution of soda and salt, the preparation of colloidal solutions of platinum and gold, etc. The following description of a method of soldering aluminium may prove useful (p. 47):—

> Aluminium, 1 part; zinc, 4 parts. After the aluminium has been melted add the zinc, then a small quantity of fat. The mixture should be well stirred, after which it may be poured into stick moulds.
>
> To apply, scrape the article bright at place to be soldered. Use a little Venetian turpentine as a soldering fluid. A thin shaving of the solder may then be placed around the joint and melted with a blow torch.

It is impossible to mention the very large number of technical and scientific principles which are described and illustrated; it must suffice to say that these range from the production of Pharaoh's serpents, through electric motors and dynamos, to wireless telegraphy and X-rays. The last nine chapters are devoted to an analysis of the principles used in research and invention. The book is well got up, and forms interesting and instructive reading.

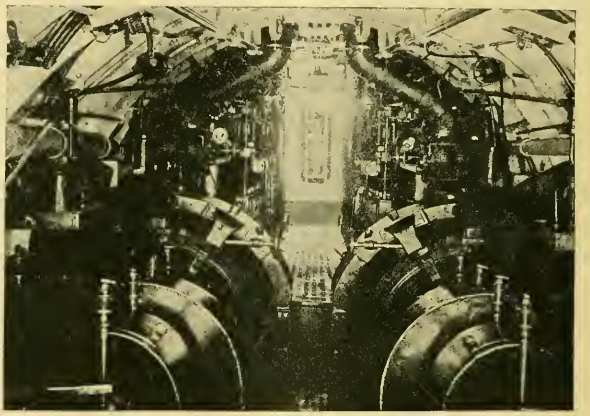

FIG. 1.—Engine room of submarine looking forward. From "Discoveries and Inventions of the Twentieth Century."

(2) Although the twentieth century is still young, Mr. Cressy has found nearly four hundred pages to be none too many in which to describe the progress of inventions made therein. The remarkable improvements which have been made in the details of most industries are clearly brought before the reader. The modern applications of water power, as exhibited in the water turbine and the Pelton wheel; the developments of the steam turbine; the Humphrey pump; improvements in gas, petrol, and oil engines, including the Diesel marine engine, and the "Gnome" engine for aeroplanes; these form a few of the developments described in the first few chapters. Electric lighting is next discussed, and some in-

[1] (1) "Experiments. A Volume for All who are Interested in Progress." By P. E. Edelman. Pp. 256. (Minneapolis, U.S.A.: Philip E. Edelman, 1914.) Price 1.50 dollars.
(2) "Discoveries and Inventions of the Twentieth Century." By E. Cressy. Pp. xvi+398. (London: G. Routledge and Sons, Ltd., 1914.) Price 7s. 6d. net.

stances in which electric heating is advisable are mentioned. Later, a brief but lucid account is given of the nature of steel, including the modern alloys of iron and manganese, chromium, nickel, and tungsten. A separate chapter is devoted to the electric furnace. An interesting and instructive chapter is devoted to the artificial production of cold, including liquefaction of gases and the methods used in cold storage. At the present time, when the advisability of increasing the productiveness of agricultural land is receiving attention, the chapters on "soil and crops" will be read with interest.

Railways, tramways, and motor-cars next receive consideration, and the wonderful developments of ship-building are ably dealt with. Great skill has been shown by the author in pointing out the scientific principles which have been utilised in each new technical advance. Thus, in connection with the speed of ships, Prof. Hele Shaw's experiments in fluid motion, and Froude's method of determining the power required to drive a full size ship from experiments on a small-scale model, are described and illustrated. Naturally enough, aerial and submarine navigation receive their due share of attention; the most important types of monoplanes, biplanes, dirigible balloons, and submarine ships are described, and an interesting section is devoted to the gyrostatic compass. Details of the construction and method of firing of the torpedo are also given. The illustrations showing the interior of a submarine (Figs. 1 and 2) will excite considerable interest.

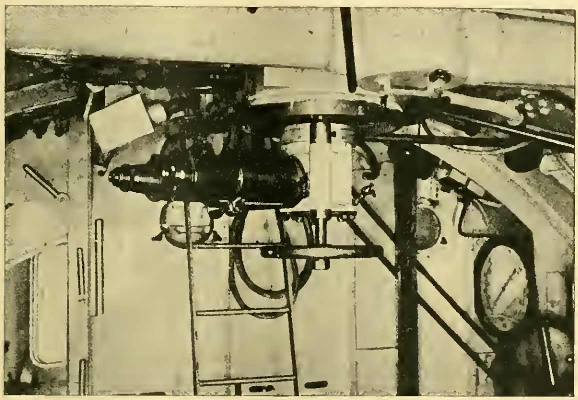

Fig. 2.—Telescope at lower end of periscope tube. From "Discoveries and Inventions of the Twentieth Century."

In reviewing this book, which contains an immense amount of material of the highest interest, it has been found impossible to do more than indicate the aim and scope of the work. Points of scientific interest are mentioned on almost every page, and the reader cannot but admire the painstaking erudition displayed by the author. Books of this character are apt to take the form of undigested summaries of inventions, only partially understood. This is not the case with the book now under review. The author could not hope, and has not attempted, to give exhaustive descriptions of the multifarious technical inventions with which he deals; but these are always described in a stimulating manner, and great accuracy is displayed throughout. The letterpress is illustrated with 281 figures and a coloured frontispiece.

Edwin Edser.

THE GOVERNMENT AND CHEMICAL RESEARCH.

The President and Council of the Royal Society and of the Chemical Society have recently had under consideration the state of chemical industry in this country as revealed by the effects of the war, and have prepared memorials to his Majesty's Government directing attention to the necessity for immediate action. On Thursday last a deputation was received by the President of the Board of Trade and the President of the Board of Education at the Board of Trade offices for the discussion of the questions raised in the two memorials. Mr. Runciman and Mr. Pease were accompanied by Dr. Addison, M.P., Sir H. Llewellyn Smith, Sir L. A. Selby-Bigge, Mr. Ogilvie, Dr. Heath, and Mr. Percy Ashley.

The deputation was introduced by Sir William Crookes, who explained the functions of the several societies represented, and it consisted of Prof. A. W. Crossley, Dr. H. J. H. Fenton, Dr. M. O. Forster, Prof. W. H. Perkin, Prof. W. J. Pope, Prof. A. Schuster, Prof. A. Smithells, Prof. J. F. Thorpe, and Mr. R. W. Harrison, representing the Royal Society; Dr. A. Scott, Prof. F. G. Donnan, Prof. P. F. Frankland, Prof. J. C. Philip, Sir W. A. Tilden, and Dr. S. Smiles, representing the Chemical Society; Mr. A. C. Chapman, President of the Society of Public Analysts, Dr. G. G. Henderson, President of the Society of Chemical Industry, and Prof. H. Jackson and Mr. E. W. Voelcker, representing the Institute of Chemistry. Sir H. E. Roscoe and Prof. R. Meldola were prevented from attending by ill-health.

Prof. W. H. Perkin, Sir W. A. Tilden, Prof. P. F. Frankland, Prof. W. J. Pope, and Dr. M. O. Forster spoke on behalf of the deputation. It was urged that the main causes of the comparatively backward state of many branches of chemical industry in this country are the general failure to realise that modern technical industry, to be successful, must be based on scientific research, and the want of intimate association between the manufacturers and the workers in science. The advisory committee which has been already appointed by the Board of Trade for the consideration of many emergency questions which have arisen, should be replaced by a permanent Standing Committee of the nature of an intelligence department serving the large and growing chemical industries of the country in the same way that the Commercial Intelligence Department serves merchants and traders. It was urged that the chemists of the country generally consider it imperative on national grounds that the development of the new organisation should be pushed forward with as little delay as possible; the expansion of the chemical industries of the country requires intimate co-operation between men of science and manufacturers, and, in view of the leeway which has to be made up, a considerable increase in the number of research workers is necessary in order to hasten progress and to insure the permanent retention of new manufactures after the war. The speakers insisted upon the need for a more intelligent appreciation of the significance of original scientific work by the Government, the urgency for increased facilities of communication between manufacturers and scientific chemical experts, and the fact that an intelligence department of the kind contemplated would, under Government auspices, form a clearing house for all the vast variety of scientific and technological chemical material which is at our disposal; such a department would form a link between the university or college, in which the chemical technologist must be trained, and the industries which would be of immense advantage to both teacher and student. The use which might have been made of the expert knowledge of such a body during the recent preliminaries to the foundation of British Dyes, Ltd., was also indicated.

Mr. Runciman, in reply to the deputation, pointed out that the Board of Trade fully appreciated the extent to which national progress is dependent upon the utilisation of the services of men of science, and the importance of provision for the thorough training of a very much larger number of industrial chemists than are at present available. He agreed with the views expressed as to the need of closer co-operation between manufacturers and scientific workers and teachers. The war had shown the weakness of our position in certain important respects, and he was in full sympathy with the general views expressed by the deputation. The actual proposals would receive careful and sympathetic consideration.

Mr. Pease informed the deputation that the particular problems to which it had directed attention had been present to the Board of Education for some time past, and that a scheme had been approved in principle by which substantial additional assistance would be given by the Government to scientific education and industrial research. He hoped that, though the funds immediately available might not be large, they would be sufficient to enable an organisation to be brought into being at an early date which would be capable of expansion afterwards. Mr. Pease further expressed his appreciation of the offer of assistance and advice by members of the societies represented at the deputation.

Sir William Crookes expressed the thanks of the members of the deputation for the sympathetic reception which they had met.

SIR WILLIAM R. GOWERS, F.R.S.

THE death of Sir William Gowers on May 4, at the age of seventy, deprives English medicine of one of its most illustrious ornaments. The state of his health—which suffered an almost complete eclipse by the death of his wife two years ago—had led to his retirement from active practice, so that the news of his death cannot have been quite unexpected. Yet it will be widely regretted, and the value of his work on the scientific side of medicine will perhaps be more completely realised than if his death had been delayed for some years.

William Richard Gowers was born on March 20, 1845. He was educated at Christchurch School, Oxford, and was for a time apprenticed to Dr. Simpson, a medical practitioner in Essex. He began his medical education at University College Hospital, London, and he had a brilliant career there, and at the University of London. He qualified M.R.C.S. 1867, took his M.B. degree in 1869, and his M.D. in 1870, winning the Gold Medal in Medicine. He became a Fellow of the Royal College of Physicians in 1879. He was also elected a Fellow of the Royal Society. He received the honour of knighthood in 1897.

Gowers's great work in medicine was in systematising the important class of nervous diseases, and in bringing into relation clinical facts with pathological changes. His early works were especially remarkable in this respect, and his clinical teaching—which was peculiarly stimulating to qualified medical men and senior students—always had this as its keynote. He would discuss fully the symptoms of what a patient complained, the clinical signs associated with these, and finally lay down definitely and clearly the changes in the nervous system which his experience had taught him were associated with these signs and symptoms.

It is not necessary here to enumerate the various medical works which he published, or to emphasise their importance. Several of them were translated into more than one European language. His chief work was the "Manual of Disease of the Nervous System," published in two volumes, the first in 1886 and the second in 1888.

Like many busy men he had, or made time for, hobbies. He was an artistic and skilful etcher, and had a great interest in, and an intimate knowledge of mosses, and also of ordinary wild flowers. He was also interested in archæology and architecture, and he himself investigated the remains of some of the old Suffolk churches, and described their character and reconstructed their history. He had early struggles and difficulties which sometimes made him seem a little austere, but as time went on his innate kindness asserted itself more and more, and his death will be deeply mourned, not only by those who benefited from his professional skill and knowledge, but by many who had experienced generous kindness at his hands.

NOTES.

AMONG the numerous portraits exhibited at the Royal Academy this year three may be specially mentioned. That of Sir Archibald Geikie, painted by Mr. R. G. Eves for presentation to the Royal Society, is a successful and welcome addition to the series of portraits of past-presidents of the society. The Hon. John Collier's portrait of Mr. C. V. Boys is not only excellent in itself, but also noteworthy for the skilful treatment of an experiment in thin films. A portrait of Dr. E. A. Wilson by Mr. H. G. Riviere, destined for Cheltenham College, is of melancholy interest as an appropriate memorial to the naturalist of the National Antarctic Expedition. A striking oil painting by Mr. John Cooke, forms a memento of a discussion on the Piltdown skull which was held in the conservator's room at the Royal College of Surgeons in June, 1913. Prof. Arthur Keith sits at a table covered with the remains of the skull, restored models, and specimens for comparison, while Prof. Elliot Smith stands behind on his right pointing to the disputed middle line of the cranium. Mr. Charles Dawson and Dr. Smith Woodward also stand behind on his left, and Sir Ray Lankester sits at the end of the table beneath them. Prof. A. S. Underwood and Mr. W. P. Pycraft are seated, one on either side of Prof. Keith, and the modeller of the restorations, Mr. F. O. Barlow, stands behind Prof. Smith. All the portraits are excellent, and the composition of the group is pleasing.

PROF. E. W. MARCHANT, of the University of Liverpool, has been elected chairman of the Liverpool Engineering Society for the coming year.

WE learn from the *Lancet* that Prof. R. Newstead, of the Liverpool School of Tropical Medicine, is in France, prosecuting entomological investigations from the point of view of military sanitation.

THE Pereira medal of the Pharmaceutical Society has been awarded to Miss Dora F. White, and the silver and bronze medals of the society to Mr. A. J. Somer and Mr. R. W. Bowles respectively.

WE learn from *Science* that the Draper medal was presented to Dr. Joel Stebbins, protessor of astronomy at the University of Illinois, at the annual dinner of the National Academy of Sciences, held on April 20.

MR. T. R. GREENOUGH and his mother have given, in memory of the late Alderman T. Greenough, a complete electrical and radiographic installation to the Leigh Infirmary. It is in three divisions, and its value is estimated at about 5000*l*.

THE Swarthmore lecture of the Society of Friends for the present year will be delivered at the Central Hall, Westminster, on Tuesday next, May 18, at 7.30 p.m., by Prof. Silvanus P. Thompson, who will speak on "The Quest for Truth." There will be no charge made for admission.

IN *Egyptian Illustration* for May Mr. W. G. Kemp announces his discovery of a partially fossilised human skull and associated remains in a cavern in the limestone of the Mokattam Hills, near Cairo. The specimens, which are considered to be prehistoric, are now being studied by Dr. Ferguson at the Cairo School of Medicine.

MR. G. MASSEE has retired from his position as head of the cryptogamic department in the herbarium at the Royal Botanic Gardens, Kew. Mr. Massee joined the Kew staff in 1893, in succession to Dr. M. C. Cooke, and he has rendered valuable service to agriculturists and horticulturists throughout the British Empire in all questions concerning plant pathology.

WE regret to learn of the death of Prof. Erich Harnack, director of the pharmacological institute of the University of Halle, and a brother of the well-known Adolf Harnack. The deceased, a native of the Baltic provinces, was a pupil of Schmiedeberg, in conjunction with whom he prepared, from choline, so-called synthetic muscarine, at one time believed to be identical with the poison of *Amanita muscaria*.

WE learn from the *Irish Naturalist* that the following naturalists in Ireland are among those who have been given commissions in the Army in connection with the present call to national service:—Prof. Gregg Wilson, professor of zoology, and Dr. A. R. Dwerryhouse, lecturer in geology, Queen's University, Belfast; Prof. H. A. Cummins, professor of botany and agriculture, University College, Cork; Mr. C. M. Selbie, of the National Museum, Dublin; Mr. G. P. Farran and Mr. A. B. Hillas, of the Fisheries Office; Mr. H. T. Kennedy and Mr. R. L. Valentine, of the Geological Survey.

THE *Pioneer Mail* for April 16 states that in spite of delays due to the European war, Sir Leonard Rogers's scheme for establishing a School of Tropical Medicine in Calcutta is progressing satisfactorily, and the time when the building will be ready for use is well in sight. The aim of the institution is to investigate specially the cause of tropical diseases and render the best possible relief on practical lines with the view of finding more accurate methods of diagnosis and improved treatment. The fund for building a hospital for tropical diseases now amounts to about 14,000*l*. (paid up), including a recent anonymous donation of 2700*l*. through Dr. K. C. Bose. Plans for the hospital are nearly ready, and the building is expected to be commenced very shortly.

THE third Wilbur Wright Memorial Lecture of the Aeronautical Society will be delivered by Prof. G. H. Bryan, on May 20, at the Royal Society of Arts, John Street, Adelphi. Gold medals of the society, awarded respectively to Prof. Bryan and to the late Mr. E. T. Busk, will be officially presented immediately before the lecture. The late Mr. Busk played a unique part in the extension to full-sized aeroplanes of the theoretical methods of calculating aeroplane stability due to Prof. Bryan, and lost his life by fire in the air while carrying out his experiments. Machines designed by the methods thus evolved form a large proportion of the valuable aerial equipment of the Royal Flying Corps. Tickets, of which the number is limited, may be obtained on application to the secretary, Aeronautical Society, 11 Adam Street, Adelphi, W.C.

Mr. C. S. Middlemiss, of the India Geological Survey, who was a native of Hull, and many years ago spent much time in investigating the geology of east Yorkshire, has made a valuable addition to the geological section of the Hull Museum. He has presented his entire collection, the specimens being all carefully labelled and catalogued, and most of them refer to east Yorkshire. Some years ago Mr. Middlemiss had an opportunity of examining the interesting sections in the Kellaways Rock at South Cave, which were made during the construction of the Hull and Barnsley Railway, and were described in the *Geological Magazine* at the time. The South Cave specimens, together with many others from the red and white chalk, etc., are included, and in addition there is a valuable series of rocks, with a catalogue giving full localities, etc. There is no doubt that Mr. Middlemiss's collection will be of great service to local geologists.

The British Fire Prevention Committee has done much useful war emergency work during the last nine months. The general honorary secretary, Mr. Ellis Marsland, has issued a statement which shows that the committee's special fire survey force of honorary surveyors has surveyed in detail about five hundred establishments taken over for war emergency work. The character and extent of these establishments varied, but often included extensive groups of buildings. The committee's warning service embraces the preparation and issue of public fire warnings disseminated in the form of posters, or as notices reproduced by technical societies, etc. More than 25,000 posters were issued to auxiliary hospitals at home, in France, in the Mediterranean, and in Egypt, as well as translations in French, Flemish, Urdu, and Panjabi. Refugees' homes and hostels in four hundred localities received about 22,000 warnings in English, French, and Flemish. The issue of farmers' warnings in connection with the epidemic of farm fires last autumn totalled more than 30,000. The number of warnings issued for premises occupied by troops exceeded 25,000. The committee's special fire service force, comprising ex-fire brigade officers and firemen, has rendered two hundred firemen with the necessary appliances readily available for mobilisation in sections within forty-eight hours. Fuller particulars of the various activities of the committee may be obtained from the office at 8 Waterloo Place, Pall Mall, London, S.W.

British zoology has suffered a distressing loss in the death of Mr. Charles H. Martin, of Abergavenny, who was killed in action on May 3, in the western battle front of the Allies, at the age of thirty-three. Mr. Martin was educated at Eton and Magdalen College, Oxford, took honours in zoology at Oxford, and devoted himself with enthusiasm to zoological research. He worked chiefly, and in recent times almost entirely, at Protozoa, and published important investigations on Acinetaria, on Trypanoplasma and allied forms, and on the cæcal parasites of fowls. Latterly he devoted himself to the study of the Protozoa of the soil, working in touch with the Rothamsted Experimental Station, and published valuable contributions to this subject, either alone or in collaboration with Mr. K. R. Lewin, of the Rothamsted Station. He was awarded the Rolleston memorial prize for his researches. For a time he was in charge of Messrs. Gurneys' laboratory at Sutton Broad, Norfolk, and afterwards assistant in the natural history department of the University of Glasgow for three years, but on his father's death he succeeded to his estate, and gave up all appointments. He continued, however, to pursue his zoological investigations with characteristic energy, in spite of the many distractions and occupations incidental to the life of a sportsman and a conscientious country squire, often carrying on researches at night after a strenuous and fatiguing day. A man of splendid physique, he joined the Officers' Training Corps early in his career, and obtained a commission in the 3rd Monmouthshire (Territorial) Regiment, of which he was an officer when he met his death. Possessed of great personal charm and of a most kindly, sincere, and generous temperament, his untimely but glorious death will be greatly deplored by all who had the privilege of being acquained with him personally, as well as by those who knew him only as one of the most promising of our younger zoologists.

In the Journal of the Royal Anthropological Institute for July–December, 1914, the Hon. John Abercromby discusses a large collection of pottery from the Canary Islands and the bearing of it upon the origin of the people inhabiting the archipelago. He arrives at the following conclusions. The archipelago was first colonised in the second, or Berber, stage of the Neolithic period by a people who spoke a Berber dialect. These colonists probably belonged to the short dolicho- and meso-cephalic stock of Hamitic type, or to the tall Cro-Magnon type. Both were of African origin, and may have arrived together or at short intervals. The short-headed people were presumably of European origin, but archæological considerations show that they may have reached the archipelago about the same time as the other two elements in the population, at any rate before the art of navigation had ceased to be known.

In a reprint from the Proceedings of the United States National Museum for April last, Mr. Oliver Hay describes remains of two extinct horses, a bison, and a musk ox, also extinct, and new to science, from the Pleistocene of North America. The author believes that it will be necessary to recognise at least two distinct species among the progenitors of our domesticated horses. One of the two supposed species is represented to-day by the large, narrow-faced horses; the other by the pony-like, broad-faced horses, especially the Celtic pony and the fjord horses of Norway.

AN interesting summary of the "Natural History of the Whale-shark" (*Rhincodon typica*), by Prof. E. W. Gudger, is given in the March number of *Zoologica*, the organ of the New York Zoological Society. Little is known of this fish, the largest of the sharks, and estimates of its length vary immensely, but it would seem that its maximum length is about 45 ft. Prof. Gudger's summary is based upon a specimen captured at Miami, Florida, during June, 1912. Unfortunately, however, he is able to write at first hand only of the stuffed skin of this fish, for the rest he has had to rely on photographs, and the account of Capt. Thompson, who harpooned it. He nevertheless brings together some valuable notes on its coloration, habits, and food, compiled from various sources.

IN "Notes on the Evidences of Age Afforded by the Growth Rings of Oyster Shells" (Fisheries, Ireland, Scientific Investigations, 1913, ii. [1914]), Miss A. L. Massy gives particulars of measurements and of the number of surface lamellæ of the shells of more than 600 oysters of known age and of various ages from eighteen months to six years. Summing up her observations as to the relation between age and the number of surface lamellæ, or growth rings, Miss Massy states that an oyster of eighteen months or two summers appears to possess at least two rings, but may have as many as five; one of three summers has at least two rings, but may have six. A four-year-old oyster may have only three rings, or may possess seven or eight. It would have added greatly to the interest of the paper if these surface rings had been compared with the number of rings shown in sections of the shell.

PUBLICATION DE CIRCONSTANCE, No. 69, of the International Council for the Study of the Sea is entitled "A Contribution to the Biology of the Mackerel: Investigations in Swedish Waters," by David Nilsson. The subjects dealt with are the relation of length to weight in the mackerel, age and growth, food, parasites, sex and maturity, eggs and larvæ, and variation. The material examined, which was collected off the west coast of Sweden, was unfortunately not very large; indeed, scarcely sufficient to justify many of the conclusions which the author attempts to draw from it. On the question of age and growth both the scales and the otoliths have been examined. In the mackerel, however, the appearances seen on both of these are very difficult of interpretation, and the figures given in the paper, which are reproductions (perhaps not very good ones) of photographs, are not very convincing. The author considers that mackerel of 120 to 210 mm. long in August, September, and October are derived from eggs spawned in the same year, although he shows that spawning in Swedish waters takes place principally in July. Much further research on a far more extensive scale is required before our knowledge of the life-history of the mackerel can be regarded as adequate and trustworthy.

IN his report on the survey operations for the year 1913–14 (New Zealand Department of Lands and Survey) Mr. E. H. Wilmot, who has recently taken up the duties of Surveyor-General, sets forth the work of the year and shows the steady progress which has been made. Work on the second-order triangulation seems to have been mainly preparatory for future field work, and to include the computation of observations previously made. The magnetographs at the observatory were kept continuously in operation, and the discussion of the field observations of the magnetic survey is well advanced. The observatory also co-operated with the staff of Captain Scott's Antarctic Expedition in pendulum observations, determination of times, transmission of time signals, etc., rendering thereby much valuable assistance to the expedition. An appendix treats briefly of the measurement of the Kaingaroa base, about 11·5 miles in length, for the second-order triangulation. The probable error of the measurements is small, but a complete discussion of the base and its relation to others in the network cannot yet be given.

THE two sections of *Science Abstracts* issued April 26 do not show any marked decrease in the number of scientific papers with which the publication has to deal in the interval between two issues. The Physics Section extends to forty-eight and the Engineering Section to forty pages. We notice in the former abstracts from the autumn and winter numbers of the *Annalen der Physik*, but there is nothing in the Engineering Section to correspond.

THE *Scientific American* for April 17 describes the American form of the metal-spraying "pistol" invented by a Swiss engineer, Mr. Schoop. A thin metal wire is fed at a suitable speed through the tube of a Bunsen burner into the flame, in which it is melted. At this point it is subjected to a rapid blast of air which blows it out of the mouth of the Bunsen in a stream of extremely fine particles. The apparatus is held in the hand very much like a pistol, and the jet may be directed on to any object which it is desired to cover with a thin film of the projected metal. The spray does not appear to damage the object on which it is deposited, and brass has been deposited on silk without its texture being injured.

THE "Appeal to Non-Producing Mathematicians," recently published by Mr. Paaswell in the Bulletin of the American Mathematical Society, and noted in NATURE, January 14, 1915 (vol. xciv., p. 541), has received a reply from Prof. C. N. Haskins in the April number of the Bulletin (vol. xxi., No. 7, p. 343). It will be remembered that Mr. Paaswell directed attention to certain outstanding mathematical problems of engineering, and comment was made in these columns on his omission of reference to aeroplane investigations. It would seem, from Prof. Haskins's comments, that engineers do not find it possible to add to their qualifications the training necessary to cope with such problems, and he suggests the desirability of mathematicians adding the necessary engineering to their mathematics. Unfortunately, however, when mathematical honourmen turn to engineering, they cease to go further in mathematics, as they find it pays better to qualify as engineers. The average mathematician who is not essentially by nature and genius devoted to pure mathematics, finds that it is more to his advantage, and is a far less arduous task, to qualify in physics, chemistry, or engineering, where he may find an outlet for his energies outside the teaching profession. Problems of the class contemplated by Mr. Paaswell depend essentially on a knowledge not so much of engineering as of *applied mathematics,* such as rigid dynamics, hydrodynamics, thermodynamics and conduction of heat, and elasticity, up to the standard of the old part ii. tripos, which is a less attractive sequel to part i. than the engineering tripos. Consequently applied mathematicians proper are few and far between, and a certain class of problems possessing no inherent difficulties is running to waste. Moreover, the few specialists interested in such work can only undertake it in the intervals between professional duties, often occupied with the teaching of engineering students of a very elementary standard.

Messrs. Dickinson and Osborne, of the U.S. Bureau of Standards describe in the April issue of the Journal of the Franklin Institute what they term an "aneroid calorimeter." It is an instrument in which equalisation of temperature is secured by means of the thermal conductivity of copper instead of by the convection of a stirred liquid. The calorimeter described, which consists of a thick walled cylindrical vessel of copper in the walls of which are embedded a coil of resistance wire to supply heat electrically, and a platinum resistance coil for use as a thermometer, has been found useful over a wide range of temperatures, and is applicable to a variety of problems. For use at low temperatures the calorimeter is mounted in a jacket surrounded by a bath of gasoline, the temperature of which can be controlled thermostatically to within a few thousandths of a degree at any temperature between $-55°$ and $+40°$ C., or can be changed rapidly in order to keep it the same as that of the calorimeter when heat is being supplied to the latter. A series of check experiments on the specific heat of water shows the order of reproducibility of results which can be obtained to be 1 part in 2000.

A note on radiation pyrometers and their characteristics, by G. K. Buyers and P. D. Foote has been communicated to the April number of the Journal of the Franklin Institute. It heralds the publication of a very complete paper which is to appear from the Bureau of Standards. Some twenty instruments have been examined, including all the ordinary types commonly met with in practice, such as the four due to Féry, and the Foster, Thwing, and Brown pyrometers. It has been established that the Stefan-Boltzmann law, $E=a(T^4-T_0^4)$, is not in general, except by accident, obeyed exactly by any of the pyrometers examined. The similar equation, $E=aT^4.T^{b-4}$ in which b is slightly different from 4 (usually neglecting the T_0 term) is, however, obeyed with sufficient exactness by all total radiation pyrometers. The main factors which influence the value of the exponent b are the geometry and mechanical construction of the instrument; the value of b for twenty thermo-electric pyrometers ranged from about 3·5 to 4·5. The same instrument of the Féry type may have a different exponent according to its use with or without the sectored diagram for increasing the temperature range.

A high-capacity wagon for the South African railways is illustrated in *Engineering* for May 7, together with another wagon of special design and 160,000 lb. capacity, built for transport of whales. These wagons have been constructed by the Leeds Forge Co., Ltd., and are excellent examples of steel rolling-stock. The whale wagon is intended to carry whales over a special 3 ft. 6 in. line a few miles in length from the point where they are brought ashore to the factory, where they are dealt with for the extraction of oil, etc., not far from Durban. The bodies are hauled on to and off the wagon by windlasses. The line is very uneven, and it has been necessary to design the wagon with six-wheeled bogies, so as to keep the axle-loads down to the required limits and ensure the necessary flexibility.

Screw pumps having blades like those of a steamer's propeller, mounted on a horizontal shaft, are a feature of several large pumping installations in the United States, particularly for drainage and flushing work, where large volumes of water must be handled promptly and rapidly. The latest and largest installation of screw pumps is at New Orleans, and is described in the *Engineer* for May 7. This installation is used in removing the storm-water drainage of the city and its surrounding district, lying between the Mississippi River and Lake Pontchartrain. Eleven screw pumps, 12 ft. in diameter, are now being built to supplement the present pumping equipment, so that the total pumping capacity will be 7,240,000,000 U.S. gallons daily. The rapid removal of storm-water by pumping has a marked influence upon the sanitary condition, since it enables the ground to dry out more rapidly, and thus reduces the unhealthy conditions which result from damp and water-soaked ground in a large city. The total annual rainfall in the district ranges from 62 to 75 in., most of the heavy rainfalls being due to severe but brief storms.

OUR ASTRONOMICAL COLUMN.

Meteors from Halley's Comet.—Like the Perseids and Leonids, the meteors connected with Halley's famous comet probably constitute a complete ring. They were first discovered by Lieut.-Col. Tupman while cruising in the Mediterranean in 1870, when the parent comet was near aphelion, and Prof. Alexander Herschel pointed out the significant resemblance between the cometary and meteoric orbits.

This year, in the early mornings of the first week in May, Mrs. Fiammetta Wilson, of Bexley Heath, observed, notwithstanding rather unfavourable weather, several splendid specimens of the Halleyan meteors. Two of these were also recorded by M. Felix de Roy, hon. secretary of the Société Astronomique d' Antwerp, but now resident at Thornton

Heath. One of these, observed on May 6, at 2h. 52m. a.m., was as brilliant as the planet Jupiter, and travelled over an extensive arc from E. to W. (Kent to Wiltshire). Its height according to Mr. Denning's computations, was from sixty-nine to fifty-nine miles, its luminous flight extended over eighty miles at a velocity of about forty miles per second. The radiant point was at $339^\circ - 2^\circ$. Another fine meteor from the same system was seen by Mrs. Wilson on May 6 at 3h. 23m. a.m., and a smaller one, also observed by M. de Roy, appeared on May 3 at 3h. 2m. a.m., with a height from forty-eight to forty miles. Radiant $335^\circ - 2^\circ$. These new materials are interesting as affording further corroboration of the identity of the comet and meteors.

Comet 1915*a* (Mellish).—The following ephemeris is a continuation of that given last week:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
May 14	19 9 32	−22 42·1	
16	14 29	25 19·2	5·9
18	20 2	28 15·4	
20	19 26 22	−31 32·7	5·6

The comet is rapidly moving southwards, and on May 18 will be found a little to the eastward of τ Sagittarii.

The Australian Solar Observatory.—The March number of the *Scientific Australian* contains a short communication by Mr. P. H. Baracchi on the demand for an Australian Solar Observatory. Mr. Baracchi enumerates the several steps that have been taken to secure such an observatory for Australia, and directs attention to the selected site known as Mount Strombo, the highest summit of a group of hills situated about 6·5 miles west of the centre of the Federal capital and about 2500 ft. above sea-level. For the purpose of testing the "seeing" at the site for the period of a year, Mr. Baracchi and his assistant, Dr. Baldwin, erected in 1911 a 9-in. refracting telescope on the site and built a 19-ft. dome to house it. The result of the observations showed that the local conditions fulfilled the most essential requirements for any class of delicate astronomical work. As yet nothing is very definitely known concerning the future of the observatory, but Mr. Baracchi states that "the Commonwealth authorities seem well disposed to expand the Mount Strombo Observatory, and make it a permanent astronomical institution, including a solar department, but no further steps have, as yet, been taken."

Photographing the Corona.—Writing in the May number of the *Observatory*, Mr. E. B. Knobel directs attention to the subject of whether the best means are employed in photographing the solar corona, and whether our knowledge of the structure of the corona has advanced since the introduction of the photographic dry plate. He is of the opinion that "no results have been secured comparable in value to the photographs of the corona in 1871, which were obtained with wet collodion plates. . . ." and that the time has arrived when the whole question should be investigated and the results of this investigation made use of on the next occasion of a total solar eclipse. In his communication he considers the merits of the three processes—daguerreotype, wet collodion, and dry plates. He refers to the difficulty in the daguerreotype process requiring much practice and experience, and to the principal drawback to its employment for the corona in that the image is only visible by reflected light, and that long exposures are necessary. He points out, however, the perfection of the resulting image. Mr. Knobel advocates strongly a serious attempt to revive the wet collodion process. He says: "There are no difficulties that cannot be surmounted. . . . All the procedure . . . requires practice and experience, and the assistant should have some familiarity with chemical operations. It ought not to be difficult to find a suitable man to train up for eclipse work among process-workers in collodion, as he would already be practised in some of the operations." It is hoped, as Mr. Knobel suggests, that some of the funds provided by the Joint Permanent Eclipse Committee may be utilised to defray the expense of the necessary training in what is almost a lost art, so that the process may be brought into use again for eclipse work.

Circulars of the Union Observatory, Johannesburg.—A batch of circulars of the Union Observatory, Johannesburg, has just come to hand dealing with a great number of varied observations. Circular No. 19 deals with the proper-motion stars south of declination -19°, and contains three tables of great interest. The first is a list of all stars for which the proper motion is known to exceed a fifth of a second of arc in either right ascension or declination. It includes also many double stars the proper motions of which exceed 0·1″, and a few stars of small proper motion. Table II. consists of those stars for which radial velocities have been published. The third table indicates groups of stars showing community of motion. The six groups given are the sun group, or group nearly stationary with regard to the sun, the 61 Cygnus, Taurus, π Mensa, α Centaurus, and δ Lepus groups. Circular No. 20, among other communications, gives an account of the discovery of variable stars, etc., with Pulfrich's blinkmicroscop, with remarks upon its use in astronomy. Circular No. 21 is devoted to observations made of the transit of Mercury in November last, a 9-in., two 6-in., and a 4-in. telescope being employed. In Circular No. 22 an orbit and observations of comet 1914*e* are given. This comet, as mentioned in this column last week, was discovered independently by several widely distributed observers. Observations of the Galilean satellites of the planet Jupiter made during the period April 8 to December 31, 1914, form the subject of Circular No. 23. These observations are in continuation of the series commenced in 1908. The present series has been compared with the times given in the American ephemeris, which are founded very closely on Damoiseau's tables, but the 1915 comparisons will be made with the Nautical Almanac, as Samson's tables have now been adopted.

SHELLFISH AND SEWAGE.

It is perhaps only by chance that the conclusion of the work of the Royal Commission on Sewage Disposal should almost coincide with the Shellfish Regulations issued by the Local Government Board. Nothing like the task performed by the Sewage Commission had ever been attempted by a similar body. It met throughout three reigns, during which time its *personnel* underwent notable changes. It interpreted liberally its "terms of reference," and conducted an inquiry which was most comprehensive in scope. It employed a scientific staff who carried out investigations of quite the best kind, and made reports which, for a long time to come, must be regarded as authoritative. It suggested legislation based on great knowledge of the conditions that were to be improved.

After all this it was with a kind of shock of surprise that those interested in the development of the inshore fisheries read the Shellfish Regulations of the Local Government Board, which were published on February 16, and came into force on March 1. For the last eight years the fisheries authorities have entreated the Board to legislate, and more than once Mr. John Burns assured them that a Bill would be drafted and laid before Parliament; it was believed that this would be necessary. The British Science Guild lent its authority in aid of the agitation. The fishing trade and the public health bodies were equally desirous that something might be done to remove the dangers that were inherent in the unrestricted exploitation of sewage-polluted shellfish beds and layings. It was felt that some comprehensive scheme of regulations, based on the well-thought-out recommendations of the Sewage Commission (and on the reports of the Board's own inspector, Dr. H. T. Bulstrode), was being prepared and awaited a favourable opportunity for consideration by Parliament.

In February last it was seen that the Board possessed power to legislate by Order in Council. Emergency legislation was in the air; and there were probably reasons traceable to the abnormal state of affairs in the country at present which stimulated the Board to action. Anyhow, the Regulations proceeded to establish a means of dealing with sewage-polluted shellfish on quite other lines than those suggested by the Sewage Commission or the fishery authorities. They set up a machinery for closing suspected layings which must invite criticism inasmuch as it can be put in motion without utilising scientific or technical skill. Briefly stated, the Regulations confer power on the local sanitary authorities to prohibit the exploitation of suspected shellfish beds or layings. If the medical officer of health of any local authority *attributes* disease of any kind in his district to the consumption of shellfish he may require the vendor of the food to state what was its place of origin. The disease need not be enteric fever, and it need not be traceable by any process of scientific investigation to the suspected shellfish. If the medical officer *suspects* (for that is what it comes to) that the consumption of shellfish from a certain place is the cause of disease he may ask the local sanitary authority in whose district this place is situated to take action. If the latter authority do not take action they can be compelled to do so by the Board.

Even then no investigation need necessarily be made. The local authority need only invite the fishermen and others interested in the industry to show cause that the shellfish which they place on the public markets are not the means of communicating disease. If they do not produce evidence of this nature the local authority may prohibit fishing on the suspected beds. It is true that the local authorities are invited to make investigations, and that it is suggested that they should base their conclusions on topographical and epidemiological evidence rather than on the results of bacteriological analyses. But many of the shellfish beds which are likely to come under suspicion may be situated in districts where the medical officer of health is a busy man with a private practice, and where the only other official to whom the investigation may be committed is perhaps an imperfectly trained sanitary inspector. No special technical training may be necessary for the consideration of "topographical and epidemiological" evidence, as it is for the conduct of a bacteriological investigation, but it is certain that evidence of the former nature is more easily misinterpreted, and is no less a matter for the expert.

It is not at all certain that this machinery will prove to be effective, for we may strongly suspect that the local authorities of the shellfish-producing districts will resent suspicion being cast on their local industries, and there is nothing to prevent them accepting the unanimous opinion of their local fishermen that the shellfish they market are to be regarded as blameless. This, however, is not our main point. Expert assistance for the investigation of the layings by the local sanitary authorities is easily procurable. There are the inspectors of the Local Government Board itself, as well as those of the Board of Agriculture and Fisheries, and some of the local fishery authorities have officers well qualified to make the necessary investigations. At all events, the sanitary authorities might well have been advised to follow the example of higher judicial bodies and obtain the assistance of assessors to help them in weighing the value of the opinions of the local fishermen. But one need scarcely say more about this; it is surely evident that the question as to whether an area of shellfish-producing foreshore is to be condemned, and a local industry destroyed, is a matter for the application of scientific investigation by men possessing special knowledge.

Then the suggestion conveyed in the covering letter of the Board, accompanying the issue of the Regulations, that stress is to be laid on the value of topographical and epidemiological, rather than bacteriological evidence, may also be criticised. There is no doubt that the Board were influenced by the opinion of the Sewage Commissioners, which rather deprecated the application of bacteriological analyses, *as a matter of routine practice*. In Dr. Bulstrode's last report no use was made of bacteriological methods; also there is, no doubt, much confusion as to "standards of impurity"; and there is no "norm" generally adopted in public health laboratories as to the precise methods of analyses. But much research upon the distribution in nature of intestinal bacteria is in progress, and we may be very sure that the extension of such investigation would soon enable us to utilise bacteriological methods with complete success—at least as an adjunct to whatever other investigations were employed. It is, in fact, unfortunate that the Regulations should have set up a machinery which can be made to work without the employment of scientific assistance, and with respect to a question upon which much research has already been made and much more suggested by the Royal Commission on Sewage Disposal. J. J.

LENGTH STANDARDS AND MEASUREMENTS.

IN his recent presidential address to the Philosophical Society of Washington,[1] Mr. L. A. Fischer, of the Bureau of Standards, gave an interesting historical account of standards of linear measure. He explained the intimate relation which existed between the American and the British official standard of length up to the year 1893. At present the yard is defined in the United States in terms of the metre, but the numerical ratio adopted agrees very closely with that legalised in this country. In fact, the American yard only differs from the British standard by about 0·0001 in. Until 1856 the United States official standard of the yard was for more than forty years a length of 36 in. on an 82-in. brass bar made by Troughton, which had been brought from London by Ferdinand Hassler, the first superintendent of the Coast and Geodetic Survey. Between 1856 and 1893 a bronze yard presented to the United States by the British Government in 1855 was recognised by the Office of Weights and Measures at Washington as the national standard.

The most important part of Mr. Fischer's address is that dealing with the measurement of base lines. During the last thirty years very radical changes have taken place in geodetical operations. End standards,

[1] Journal of the Washington Academy of Sciences, March 4, 1915, vol. v No. 5, pp. 145–159

"compensated for temperature," were in use when Mr. Fischer was first engaged on the Coast and Geodetic Survey. These gave place to 5-metre contact rods, consisting of a single bar of steel enclosed in a closely fitting wooden case, and covered with padded canvas. For use in the field they were mounted on tripods and placed end to end. In the hands of skilled observers it was possible with this type of bar to attain a degree of accuracy approaching 1 part in 2,000,000. In the elaborate apparatus devised by Dr. R. S. Woodward a line bar was supported when in use on a steel trough and covered with crushed ice, the trough being carried by two trucks travelling on a portable track. Micrometer-microscopes were mounted on supports fixed in the ground at carefully measured intervals approximately equal to the length of the bar. The operation of measuring was effected by bringing the bar under the first two microscopes and then setting the cross-wires of the micrometers on the lines of the bar; then without disturbing the reading of the forward micrometer the bar was displaced longitudinally until the line at its rear end was brought under the forward microscope, while at the same time an observer at the forward end set the micrometer on the line at that end, this process being repeated throughout the length of the base line. A kilometre base measured in this manner was estimated to have an accuracy of 1 part in 3,000,000.

Eimbeck's duplex base bars were next employed on the survey. These consisted of two concentric brass tubes in the inner of which a brass and a steel measuring bar were mounted. The inner tube could be rotated through 180° so as to equalise the temperature of the brass and steel components if one side of the apparatus should be more exposed to direct radiation. This method was in its turn superseded by the introduction of invar tapes. All primary bases of the United States Survey are now measured with invar tapes, tested preliminarily at the Bureau of Standards, and by this means base operations, while maintaining the high degree of precision which the work demands, admit of vastly greater rapidity in the field, with a consequent reduction in the expense involved.

PLIOCENE MAN.

THE discussion originated by the Rev. Osmund Fisher in NATURE of September 4, 1913 (vol. xcii., p. 6), has led to the systematic exploration, by a committee of the Dorset Field Club, of the Dewlish "elephant-trench," and the report on the excavations was read at the anniversary meeting on May 4.

This curious trench in the chalk yields bones of the Pliocene *Elephas meridionalis*, and Mr. Fisher suggested that it was artificial and dug for trapping the elephants. There can no longer be any doubt that the trench was of natural origin. The elaborate plans, elevations, and photographs exhibited by Mr. Charles Prideaux, who superintended the excavations, show clearly that a few feet below the surface the supposed trench divides into a chain of pipes or pot-holes in the chalk connected by a narrow joint. These become very narrow below; but one of them was traced to a depth of 36 ft. One or two of the smaller pipes still show traces of the lining of black clay commonly found in pipes caused by solution in the chalk; the larger ones were filled with chalky sand full of flints, and Tertiary material; many of the flints were beautifully polished. Flakes caused by sudden changes of temperature were also abundant.

Mr. Clement Reid discussed the geological evidence. He thought that it proved the existence of a fissure or joint transverse to the valley of the Devil's Brook. Along this joint a chain of pipes was formed by the action of percolating rain-water. Then the pipes nearest to the valley-bottom acted as "swallow-holes," into which the brook sank, the constant swirl of the water laden with calcareous sand giving the flints the wonderful polish now seen. In short, the Devil's Brook, then flowing at a level 90 ft. higher, was a "winter bourne," which at Dewlish, for part of the year, at any rate, was swallowed up and disappeared into these pot-holes. Such pot-holes are common in the Carboniferous Limestone, though rare in the Chalk. This chain of pot-holes acted as a natural pitfall, into which the elephants fell, or into which their bones were washed; thus far Osmund Fisher was right in calling it an "elephant-trap," though it probably had a natural origin. Mr. Reid saw no sign of human agency in the trench. The date of the deposit must still remain somewhat uncertain, for all the determinable bones belong to *E. meridionalis*, and this species, though mainly Pliocene, may have lived on into early Pleistocene times.

Mr. Reid Moir, in another report, described a number of the flints as showing undoubted human workmanship of eolithic type. Mr. Reginald Smith, however, after an examination of the same specimens, thinks that one or two of them may possibly be worked, the others he rejects.

A report by Mr. Dewey pointed out that a sample of calcareous sand from the trench proved under the microscope to consist mainly of minute rhombs of calcite, such as would be precipitated from a saturated solution. This he thought pointed to an arid climate.

SYSTEMATIC ZOOLOGY OF THE INVERTEBRATA.

AMONG recent systematic papers on the invertebrates, a noteworthy account of the parasitic worms collected on the British Antarctic (*Terra Nova*) Expedition, written by Dr. R. T. Leiper and Dr. E. L. Atkinson, has been published by the British Museum ("*Terra Nova* Zoology," vol. ii., No. 3). From the summary of results we learn that the Ross Expedition of 1841–4 brought back two species of Entozoa; the Scott (*Discovery*) Expedition of 1901–4 four species; the Bruce (*Scotia*) Expedition seventeen species; the French (*Pourquoi Pas?*) Expedition eighteen species; the *Terra Nova* twenty-eight species. These figures show how greatly zoological knowledge has been increased through our latest national Antarctic enterprise. Three of the worms now recorded from the far south had previously been known only from the Arctic regions. Two of these—a Filaria and an Echinorrhynchus—have whales as their hosts in both localities, but the third—a monostomid trematode, *Ogmogaster plicatum*, Creplin—is parasitic in rorquals in the north, and in the Crab-eating and Weddell's Seals in the south; a remarkable divergence in habit.

From home waters there is still much material to be gathered, and C. M. Selbie's important paper on the Decapoda Reptantia of the coasts of Ireland, part 1 (Fisheries, Ireland, Sci. Invest., 1914, i.), adds to the fauna of the Britannic marine area the family Eryonidæ, as represented by four species of Polycheles and four of Eryonicus. These were all taken in deep water off the west coast of Ireland, though the specimens of Eryonicus "lead a free-swimming life at a considerable distance from the bottom." The paper is illustrated by fifteen excellently drawn plates.

A very important paper on those interesting copepod fish-parasites, the Lernæopodidæ, has been published by C. B. Wilson in the *Proc. U.S. Nat. Museum* (vol. xlvii., pp. 565–729). Though dealing especially with species from North American waters, the author gives a revision of the whole family, thus affording a trustworthy work of reference for students of the group all over the world. The systematic part of the paper is preceded by a useful introduction to the anatomy and metamorphosis of the parasites, and is illustrated in thirty-two clear plates of diagnostic drawings.

The zoological results of the Abor Expedition (N.E. India) continue to appear in the Records of the Indian Museum. The lately issued part 6 of vol. viii. contains papers on land planarians by Prof. R. H. Whitehouse, terrestrial Isopoda by W. E. Collinge, and Onychophora by Stanley Kemp. The last-named deserve more than passing notice, for the discovery of a Peripatid "at the foot of the eastern Himalaya" is one of the most important faunistic results of recent years; no member of the class had hitherto been found at all as far north as this. The specimens were found under stones in a comparatively small area at an elevation of 1320 ft. From a consideration of the structure of the species, Mr. Kemp considers it allied to the Malayan Eoperipatus, but on account of the total absence of eyes (although the optic ganglia are present), and other distinctive characters, establishes a new genus (Typhloperipatus) for its reception. The unpaired oviduct in the female and the ejaculatory duct (also unpaired) in the male are remarkably long. The eggs are richly yolked, and embryos at various stages were found in the uterus. From the appearance of the embryos and young it is concluded that reproduction takes place only during the wet season.

G. H. C.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Messrs. F. T. Brooks, Emmanuel College, and K. H. Compton, Gonville and Caius College, have been appointed demonstrators of botany, and Mr. T. S. P. Strangeways, St. John's College, has been reappointed demonstrator of physiology. The council recommends to the Senate that the Vice-Chancellor be authorised to countersign and seal certificates of attendance to Belgian students attending the courses of instruction organised by Belgian professors now lecturing in Cambridge.

The Financial Board has presented a report to the Senate in which the financial position and prospects of the University are reviewed. The income of the University chest for 1913 and 1914 was 53,400*l.* and 46,800*l.* respectively, and is estimated at 26,600*l.* for 1915; the corresponding figures representing the receipts of the common University fund are 22,510*l.*, 23,800*l.*, and 15,780*l.* Details are given in the report of the manner in which the board proposes to meet the large deficiency disclosed in the estimates by the temporary suspension of vacant teaching and research posts, of salaries to officials now in the national service, and of contributions to pension and building sinking fund accounts. One of the most substantial items of expenditure under the control of the Financial Board is that of grants to the departmental funds of the scientific departments of the University; these amounted to 5580*l.* in 1914. The accounts of these departments, although controlled by the Board, are not incorporated in those of the University chest or the common University fund, but the board estimates that in 1915 the receipts from fees of the scientific departments of the University will fall some 16,000*l.* to 18,000*l.* below those of 1914. It is evidently not desired that the University contribution towards the upkeep of the science laboratories in the University should be diminished; it is obvious, however, that even in normal times the chest and the common fund could do little to support natural science in Cambridge if the annual revenue of the science laboratories were suddenly diminished by 16,000*l.* to 18,000*l.* The *Cambridge Review* records the number of undergraduates in residence this term as 1097, as against 3181 during the Easter term of 1914.

LONDON.—Lord Rosebery presided at the presentation of graduates on May 5. The annual report of the principal (Sir Henry Miers), his seventh and last report in view of his appointment as Vice-Chancellor of Manchester University, referred to the special work resulting from the war, particularly the training of 1300 officers and educational provision for two hundred refugee students. In his retrospect of his period of office, the principal referred to the report of the Royal Commission, the incorporation of King's College and King's College for Women in the University, the Universities' Congress, the transfer of Bedford College to Regent's Park, the new buildings at the Imperial College and University College, the development of the professoriate, the increase of internal students from 3580 to 4950, and in the number of external candidates, and many benefactions for teaching and research. He looked forward to the time when the University would have a dignified home bearing its own name, and would be adequately endowed; and expressed his complete faith in its power to fulfil all its duties, both local and imperial. Lord Rosebery, in an eloquent address, hoped that as one result of the war, a new spirit of co-operation would enable the University to work out its own salvation. He had never believed that there was anything incompatible between the local and imperial aspects of the work of the University.

The London County Council is prepared to award for the session 1915–16 a limited number of free places at the Imperial College of Science and Technology, South Kensington, S.W. The free places will be awarded on consideration of the past records of the candidates, the recommendations of their teachers, the course of study which they intend to follow, and generally upon their fitness for advanced study in science as applied to industry. Candidates will not be required to undergo a written examination. It is possible that the free places may be extended to two or more years. Particulars may be obtained from the education officer, L.C.C. Education Offices, Victoria Embankment, W.C., and application forms must be returned not later than Saturday, May 22.

SHEFFIELD.—Dr. J. Sholto C. Douglas, lecturer on pathology in the University of Manchester, has been appointed to the Joseph Hunter chair of pathology, in succession to Prof. Dean.

FOUR lectures on the progress of public health in Egypt will be delivered at Gresham College, E.C., on May 18–21, by Prof. F. M. Sandwith, Gresham professor of physic. The lectures are free to the public, and will begin each evening at six o'clock

WE learn from *Science* that grants for two new buildings to meet the needs of the University of Ohio and for additional tracts of farm land west of the Olentangy have been voted through the finance committee of the lower branch of the State legislature. These extensions would involve an expenditure of 68,000*l.* A domestic science building to cost 30,000*l.* and a shop building for manual training to cost 24,000*l.* are provided. Ninety acres of land would be purchased west of the Olentangy River at a probable cost of 14,000*l.*

A SUMMER School of Mining and Engineering for the South Wales coalfield is to be held in August next at the Technical College, Swansea. The courses of instruction will be seven in number, comprising a surveyor's course (to meet the requirements of the

Coal Mines Act, 1911), one in engineering, one in metallurgy, one for architects and builders, one for teachers (dealing with geology, physics, and chemistry), one on the electrification of collieries, and one on gas detection and analysis and by-product recovery. Further particulars can be obtained from the chief education official, County Hall, Cardiff.

THE number of foreign students in German universities, according to the *Nieuwe Courant*, was 1438 during the last winter semester, as against 4715 in the previous summer. The decline is primarily due to the removal of about 2600 students belonging to hostile countries. The students from Austria-Hungary numbered 547, as against 814 last summer; the corresponding decline was:—For Switzerland from 312 to 146; for Rumania 146 to 111; for Bulgaria 131 to 105; for Holland there was an increase from 37 to 44. During the war foreign students have shown a strong preference for Berlin; the chief decline in their numbers being at Königsberg, Göttingen, Marburg, Munich, Strassburg, Freiburg, and Heidelberg.

SEVERAL gifts in aid of higher education are announced in the issue of *Science* for April 23. Harvard University receives 20,000*l*. by the will of the late Mr. James J. Myers, of Cambridge, Mass., and further bequests amounting to 14,600*l*., to be devoted to cancer research at the Harvard Medical School, are announced. By the will of Mrs. L. L. Ogden Whaling, of Cincinnati, Miami University receives 54,000*l*. The residue of the estate is to be divided between Miami University and the Cincinnati Museum Association, and it is said that each institution may receive 40,000*l*. The Addison Brown collection of plants offered to Amherst College by Mrs. Brown in memory of her husband has now come into possession of the college. Containing many thousands of specimens collected in the United States, Mexico, Porto Rico, the Hawaiian Islands, and elsewhere, it is the largest accession ever received by the department.

THE Imperial Department of Agriculture for the West Indies has issued revised courses of reading and examinations in practical agriculture. Reading courses have for some years been established under the direction of the department for the purpose of enabling overseers on estates, and others engaged in agriculture, to acquire by reading knowledge they can apply in their everyday work. Examinations are held periodically at various centres in the West Indies for persons who have previous been registered as students in reading courses. Registration in reading courses entitles students to certain publications of the department which are recommended for reading. The certificates awarded by the department at the examinations are intended to be a guarantee of a sound general knowledge of the fundamental principles underlying the practice of agriculture, and also a practical knowledge of at least two crops and their products, such as sugar, cacao, cotton, limes, rice, coco-nuts, and bananas.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 6.—Sir Alfred Kempe, vice-president and treasurer, in the chair.—G. W. **Walker**: Some problems illustrating the forms of nebulæ. The paper is concerned with the form of the surfaces of equal density when a quantity of gaseous material at uniform temperature, and following Boyle's law as regards pressure and density, is at rest under its own gravitation. The differential equation for these surfaces is not linear. In the two-dimensional case Pockels obtained the solution in terms of two arbitrary functions of complex variables. In the paper the solution is put in a form which must give real positive density anywhere. Three cases only are considered which illustrate respectively a ring nebula, a pear-shaped nebula, and a nebula with two equal nuclei. Some consequences of motion of the material are considered.—Hon. R. J. **Strutt**: Observations on the resonance radiation of sodium vapour. (1) The centres emitting resonance radiation of sodium vapour excited by the D lines are not persistent enough to be carried along when the vapour is distilled away from the place of excitation. This result is extraordinary, because it contrasts absolutely with the behaviour of sodium vapour excited electrically. It also contrasts absolutely with the behaviour of mercury vapour, whether excited optically (2536 resonance radiation) or electrically. (2) The resonance radiation of sodium cannot be seen through even a very dilute layer of sodium vapour placed in front of it—a layer quite transparent to white light. This explains why the spot of superficial resonance produced on the wall of a glass bulb can only be seen from in front, when the light passes to the eye without traversing sodium vapour. From the back it cannot be seen, as Dunoyer has observed. (3) The resonance radiation of sodium vapour is changed in intensity when the vapour is placed in a magnetic field. If the exciting flame is weakly salted, the radiation diminishes with increasing field strength. If the exciting flame is strongly salted, the radiation increases to a maximum and then diminishes again. (4) A change in intensity of resonance radiation can also be observed when the exciting flame is placed in the magnetic field. In this case a weak flame gives diminished radiation in the field, while a strong flame gives increased radiation in the field. (5) All the facts summarised under (3) and (4) can be explained qualitatively and quantitatively, so far as the available data will go, by taking into account the known Zeeman resolution of the D lines, and the observed width and structure of these lines as emitted by the flames used. The latter data were obtained by observation with a concave grating of high resolution.—Hertha **Ayrton**: Local differences of pressure near an obstacle in oscillating water. When the water is approaching the mean level there is a diminution of pressure, or partial vacuum, created in the lee of the obstacle. When the water is departing from the mean level the diminution of pressure continues high up on the lee side, but over the lower part there is a pressure in the opposite direction to that of the main stream. The jet in the first part of a swing is due to the local current created by the local difference of pressure; the vortex in the second part of the swing is due to the conjunction of the main stream with the opposing local current set up by the local pressure difference.

Geological Society, April 14.—Dr. A. Smith Woodward, president, in the chair.—S. H. **Warren**: Further observations upon the Late Glacial, or Ponder's End, stage of the Lea Valley. With notes on the Mollusca by A. S. **Kennard** and B. B. **Woodward**. The paper is supplementary to one previously published, and describes additional sections which increase the range of the deposits. They have now been traced for a distance of $6\frac{1}{2}$ miles along the valley and $2\frac{1}{4}$ miles across it. The section at Hedge Lane, Lower Edmonton, shows several thick, and for the most part undisturbed, Arctic plant-beds, which occur in a deep Drift-filled channel. The relative levels and stratigraphy point to the conclusion that the Hedge Lane deposits belong to a slightly earlier stage of the Low-Terrace River-drift than the deposits of Ponder's End. Broadly speaking, they undoubtedly belong to the same group. It is suggested that it would be a convenience if the

East Anglian word "platymore" were adopted for the underlying eroded floor of country-rock beneath a later accumulation of drift. The importance of this "platymore" surface in the correlation of Drift deposits has been increasingly recognised during recent years. The view that the lower river-terraces are later than the higher river-terraces is supported. Further evidence is also brought forward in support of the view that the Arctic deposits form an integral part of the Low-Terrace Drift. One section appears to suggest that the climate became nearly as temperate as that of the present day before the mammoth and woolly rhinoceros became extinct.

April 28.—Dr. A. Smith Woodward, president, in the chair.—Prof. G. A. J. **Cole**: A composite gneiss near Barna in the County of Galway. The great mass of granite west of Galway town is seen on its northern margin to be intrusive in a metamorphosed series of Dalradian quartzites, limestones, and mica-schists, and has received a foliation which is parallel with the bedding of this series; this foliation is ascribed by the author to the partial absorption of sheets of the bedded series into its mass. Traces of similar intermingling occur in Townparks (Galway town) and west of Barna. At Furbogh Bridge, the granite contains pink crystals of orthoclase, at times 10 cm. long in the direction of the vertical axis, and these have become stranded, as it were, among the foliation-planes of dark green biotite-schist, into which they were carried by an intimate intermingling of the granite with the schist into which it flowed. Quartz and smaller felspar-crystals from the granite abound in the resulting composite gneiss, and the general effect is comparable with that of igneous intermixtures described from County Down and Skye. In the Galway instance, however, there is no sign of general fusion of the invaded rock, which retains its original foliation and controls the structure of the composite mass.—Prof. S. H. **Reynolds**: Further work on the igneous rocks associated with the Carboniferous Limestone of the Bristol district. The paper gives an account of the additional information, concerning the Carboniferous volcanic rocks of north Somerset, which has become available, largely through digging trial-holes, since the publication in the Q.J.G.S. for 1904 (vol. lx.) of a paper by Prof. Lloyd Morgan and the author on the subject. The rocks occur at five localities:—(1) Goblin Combe; (2) Uphill; (3) Limeridge Wood, Tickenham; (4) Spring Cove and Milton Hill, Weston-super-Mare; and (5) Woodspring or Middle Hope. At Goblin Combe, as the result of digging nearly forty trial-holes, it was ascertained that the igneous rocks form two discontinuous, somewhat crescentic masses, each consisting of olivine-basalt overlain by a considerable thickness of calcareous tuff. At Uphill, the evidence obtained was insufficient to determine whether the basalt is a sill or a lava-flow. At Limeridge Wood, Tickenham, where only débris of basalt had previously been recorded, the presence of an oval mass measuring about 60 by 25 yards was proved by digging trial-holes, and the fact that it is completely surrounded by limestone indicates its intrusive character. Several additional exposures are described on Milton Hill, where the lava forms a band about 150 ft. thick. The lava at Middle Hope or Woodspring is shown to form an irregular and discontinuous mass.

Royal Meteorological Society, April 21.—Capt. H. G. Lyons, president, in the chair.—H. Helm **Clayton**: A study of the moving waves of weather in South America. It is the custom in most meteorological services for the forecaster to make a mental estimate of the changes to be anticipated during the succeeding twenty-four or forty-eight hours. In order to improve on this method and to raise forecasting from an art to a science, the author believes it is essential to replace estimates by quantitative measurements of expected changes and to make quantitative forecasts. He gave an interesting example of such a method as applied to one of the Argentine weather maps. —E. H. **Chapman**: Correlation between changes in barometric height at stations in the British Isles. This was an attempt to discover the relationships existing between the changes in the barometric height at one place and another during the same and also different intervals of time. The conclusion arrived at is that the best information for foretelling barometric changes at any station is from a station south-west of it, the statistical measure of the accuracy with which such a change can be foretold being expressed in a correlation coefficient.

Manchester.

Literary and Philosophical Society, April 13.—Mr. F. Nicholson, president, in the chair.—H. **Day**: Some points bearing on the relationship of the fishes and the amphibia. The author deals with three specimens of the so-called parasphenoid bone in *Rhadinichthys monensis* from the Manchester Museum collection. The three specimens together give an excellent idea of both dorsal and ventral surfaces of the bone, so that an accurate description can be given, thus providing material for a determination of the relations and homology of this bone in the Crossopterygian fishes and in the primitive Reptilia and Amphibia. It was shown that in all these groups the bone is really compound, consisting of parasphenoid and basisphenoid combined, and also that the bone is remarkably constant in its form and relations. The remarkable constancy in form was contrasted with the entirely different form of parasphenoid which prevails in fossil and living Dipnoi, and was brought forward as a strong argument in favour of a development of the Tetrapoda from a Crossopterygian Ganoid stock rather than from the Dipnoi. Further, it was pointed out that in all cases this bone takes part in the suspension of the upper jaw, a process of the metapterygoid region of the palato-quadrate uniting with the basipterygoid process of the basisphenoid region of this compound para-basi-sphenoid bone. This "pedicular" connection thus constitutes a form of autostyly common to the Crossopterygii and the primitive Amphibia and Reptilia, but totally different from the autostyly found in Dipnoi, which latter type is never found in the Tetrapoda. Hence the common pedicular autostyly forms another argument in favour of a Crossopterygian derivation of the Tetrapoda as opposed to the Dipnoian derivation.

Paris.

Academy of Sciences, May 3.—M. Ed. Perrier in the chair.—Gaston **Darboux**: The representation on a plane of the surface of the fourth order with double conic.—G. **Bigourdan**: The comparison of the scintillation and the instrumental undulations of celestial images under various influences. Supplementing an earlier communication the effects of magnetic disturbances, aurora borealis, barometric depressions, neighbourhood of clouds, azimuth, and twilight are discussed, the observations of various observers on these points being quoted.—M. de **Sparre**: The trajectory of projectiles thrown from aeroplanes or balloons.—Pierre **Delbet**: A prothetic apparatus with co-ordinated movements for use after amputation of the thigh. The apparatus described facilitates walking and conceals the deformity.—J. Kampé de **Fériet**: A generalisation of the series of Lagrange and of Laplace.—Pierre **Humbert**: A figure of equilibrium of fluids in rotation.—E. **Vaillant**: The laws of flow in drops through capillary orifices.—Léon **Bloch**: Optical resonance in the magnetic field.—A. **Leduc**: The determination of the ratio γ by means of the velocity of sound. A discussion of the values of the ratio of the two specific heats of gases and vapours obtained from experimental determinations of the velocity of sound. The author concludes that the values of γ thus obtained are generally inexact.—N. **Arabu**: Studies on the tertiary formations of the basin of the Sea of Marmora.—Henry **Hubert**: The distribution of rain in western Africa.—Henri **Coupin**: The morphogenic action of increased salinity on the marine bacteria. Increasing the salt percentage in the culture media of marine bacilli increases the length of the organisms and in some instances transforms them into true Spirillæ.—Robert **Sorel**: Wounds received in battle and the sun cure. A list of cases cured in the Alexandra Hospital at Monte-Carlo by sun treatment.—Maxime **Ménard**: The radioscopic localisation of foreign bodies by the method of Hirtz.

CALCUTTA.

Asiatic Society of Bengal, April 7.—P. **Brown**: A preliminary note on the prehistoric cave paintings at Raigarh. These were originally discovered on the rock-surface of a shallow cave in the State of Raigarh, Central Provinces, by Mr. C. W. Anderson, of the B.N. Railway, in 1910. This note is the result of a visit to the caves in March, 1915, by the author and Mr. C. W. Anderson. Certain geological evidences were obtained on the occasion, such as agate implements, etc., which have been submitted to the Geological Survey for investigation. The cave containing the paintings is apparently only the ruin of a much larger excavation. At some remote age the entire front must have fallen in, thus hermetically sealing up the cave and preserving the drawings. At a much more recent date the débris which had thus closed up the opening broke away and slipped another stage down the cliff, exposing the remains of the paintings to view. The paintings are mainly hunting scenes, and in some instances bear a remarkable resemblance to the cave paintings at Cojul in Spain, which are said to be 50,000 years old. In the technique there is also a striking similarity to some of the "cross lined" pottery of prehistoric Egypt. The paintings are evidently of very great antiquity, probably older by thousands of years than any other paintings yet discovered in India.—J. **Evershed**: Sun-spots and prominences.—W. **Burns** and S. H. **Prayag**: Grafting the mango-inflorescence. Starting from the observation that the inflorescence of *Mangifera indica*, L., often becomes partly or wholly vegetative, a phenomenon already studied by Burkill and Bose, the authors give an account of experiments on the artificial production of mixed inflorescences by grafting an inflorescence either on a vegetative branch or on another inflorescence, the grafted inflorescence either dying after the ripening of the fruit which it bears or sometimes persisting and producing vegetative axillary branches.—M. O. Parthasarathy **Iyengar**: Observations on the defoliation of some Madras trees. The author takes as his starting point the observation that, in Madras, trees do not remain in a leafless condition during the period of drought, but produce fresh leaves during the latter period, and he concludes that, in the case of Madras trees, the leaf-fall is not due to the failure of water-supply, but possibly due to the necessity of a replacement of the old by fresh, physiologically more efficient leaves, the greater efficiency of the latter being due to their cuticle being less permeable to water, to their stomatal mechanism being more perfect, to their being less charged with excretionary matter and less clogged by dust, and to greater vitality. The fall of the older leaves may also be caused by successful competition of the growing young leaves for supply of materials. The author also directs attention to the fact that prolonged wet weather may cause trees to shed their leaves. He deals in greater detail with a group of trees—called by him the Odina group—which remain in a leafless condition for a considerable length of time, and which flower while in the leafless condition. Defoliation due to salt-laden sea-breezes is referred to, and a number of special cases are considered in greater detail.—P. F. **Fyson**: Note on the flora of the South Indian Highlands. The region considered comprises those parts of the Nilgiri and Palney Hills which rise above the 6500-ft. level. Forty-five per cent. of the 430 indigenous phanerogamic species are endemic in South India and Ceylon, 17 per cent. are shared with the Khasia Hills, 12 per cent. occur also in the temperate Himalayas, and 9 per cent. are Chinese and Japanese.—W. F. **Smeeth**: The geological history of southern India. A general account of the geology of Mysore.—H. C. **Das-Gupta**: Palæontological notes from Hazara. In this paper the author has described a few fossils obtained from the Triassic, Jurassic, Gieumal, and Tertiary beds of Hazara, and these fossils include one new species of Corbula (*C. middlemissii*), and another new species of Nautilus (*N. hazaraenois*).—H. V. **Nanjundayya**: Some aspects of ethnographic work.

BOOKS RECEIVED.

The Earth: its Life and Death. By Prof. A. Berget. Translated by E. W. Barlow. Pp. xi+371. (New York and London: G. P. Putnam's Sons.) 7s. 6d. net.

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

Fly-Fishing: Some New Arts and Mysteries. By J. C. Mottram. Pp. xii+272. (London: The *Field and Queen* (Horace Cox), Ltd.) 5s. net.

Improved Four-Figure Logarithm Table. By G. C. McLaren. Pp. 27. (Cambridge: At the University Press.) 1s. 6d. net.

The Golden Bough. By Sir. J. G. Frazer. Third edition. Vol. xii. Bibliography and General Index. Pp. vii+536. (London: Macmillan and Co., Ltd.) 20s. net.

The Complete Science of Fly Fishing and Spinning. By F. G. Shaw. Pp. xiii+432. (London: The Author, Neville Court, Abbey Road, N.W.) 21s.

Tropical Diseases Research Fund. Report of the Advisory Committee for the Year 1914. Pp. iv+248. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2s. 3d.

New Zealand. Department of Mines. N.Z. Geological Survey. Palæontological Bulletin, No. 2. Revision of the Tertiary Mollusca of New Zealand. By H. Suter. Part i. Pp. v+64+plates. (Wellington, N.Z.: J. Mackay.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1914. Pp. 112. (Hobart: Royal Society.)

Land and Freshwater Mollusca of India. Supplementary to Messrs. Theobald and Hanley's Conchologia Indica. By Lieut.-Col. H. A. Godwin-Austen. Vol. ii. Plates cxxxiii–clviii. Vol. ii. Part xii. December. Pp. 311–442. (London: Taylor and Francis.) 25s.

Practical Physical Chemistry. By J. B. Firth. Pp. xii+178. (London: Methuen and Co., Ltd.) 2s. 6d.

Index to Periodicals. Compiled by various authorities and arranged by A. C. Piper. Vol. i. April–September, 1914. Pp. xxxii+192. (London: Stanley Paul and Co.) 21s. net.

Bacon's Contour Atlas. Lancashire and Yorkshire edition. Pp. 41. South Wales edition. Pp. 41. North England edition. Pp. 41. (London: G. W. Bacon and Co., Ltd.) Each 6*d*. net.

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

A First Geography of the British Isles. By W. M. Carey. Pp. vi+169. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Haeckel's Frauds and Forgeries. By Prof. J. Assmuth and E. R. Hull. Pp. 104. (London: B. Herder.) 6*d*. net.

Combinatory Analysis, by Major P. A. MacMahon. Vol. i. Pp. xix+300. (Cambridge: At the University Press.) 15*s*. net.

The Medical Annual, 1915. Pp. cxx+830. (Bristol: J. Wright and Sons, Ltd.; London: Simpkin and Co., Ltd.) 10*s*. net.

DIARY OF SOCIETIES.

THURSDAY, May 13.

Royal Society, at 4.—Election of Fellows. At 4.30.—The Development of the Thymus, Epithelial Bodies and Thyroid in the Vulpine Phalanger (*Trichosurus vulpecula*): Elizabeth A. Fraser and Prof. J. P. Hill.—Some Observations on the Development of the Thymus, Epithelial Bodies and Thyroid in Phascolarctos, Phascolomys and Perameles: Elizabeth A. Fraser.—Measurement of the Specific Heat of Steam at Atmospheric Pressure and 104·5° C., with a Preface by Prof. H. L. Callendar.—Thermal Properties of Carbonic Acid at Low Temperatures. II.: C. F. Jenkin and D. R. Pye.

Royal Institution, at 3.—The Movements and Activities of Plants: Prof. V. H. Blackman.

Royal Society of Arts, at 4.30.—Indian Trade and the War: Sir C. H. Armstrong.

Iron and Steel Institute, at 10.30.—A Selection of: Diffusion of Carbon in Iron: F. W. Adams.—Supplementary Notes on the Forms in which Sulphides may exist in Steel Ingots. II.: Prof. J. O. Arnold and G. R. Bolsover.—Researches on Iron, Silicon and Carbon Alloys: G. Charpy and A. Cornu.—Corrosion of Iron in Aqueous Solutions of Inorganic Salts: Dr. J. A. Newton Friend and P. C. Barnet.—(1) Relative Corrodibilities of Gray Cast Iron and Steel; (2) Note on the Removal of Rust by means of Chemical Reagents: Dr. J. A. Newton Friend and C. W. Marshall.—Communication on the Heating of an Open-hearth Furnace by means of Tar: Dr. A. Greiner.—Sound Steel Ingots and Rails: Sir R. A. Hadfield and Dr. G. K. Burgess.—The Nature of the A_2 Transformation in Iron: K. Honda.—Brinell Hardness and Tenacity Factors of a series of Heat-treated Special Steels; Dr. A. McWilliam and E. J. Barnes.—Thermo-electric Properties of Special Steels: A. M. Portevin and E. L. Dupuy.—Stress-strain Loops for Steel in the Cyclic State: Dr. J. H. Smith and G. A. Wedgwood.—Detection of Burning in Steel, and Iron, Carbon, and Phosphorus: Dr. J. E. Stead.

FRIDAY, May 14.

Royal Institution, at 9.—The Archives of Westminster Abbey: Rev. E. H. Pearce.

Iron and Steel Institute, at 10.30.—A Selection of Papers mentioned above.

Royal Astronomical Society, at 5.—Measures of Double Stars: E. Doolittle.—The Mechanics of Spiral Nebulæ: S. Brodetsky.—Note on Schjellerup's Discussion of the Occultations in the Amalgest: J. K. Fotheringham.—The Irregular Movement of the Earth's Axis of Rotation: Contribution towards the Analysis of its Causes: Sir J. Larmor and Col. Hills.—Note on the Solution of Hill's Equation: Sir J. Larmor.—A Method of Solving Spherical Triangles, etc., by the Use of a Simple Table of Squares: H. H. Turner.—The Short Period Variable RR Lyræ: C. Martin and H. C. Plummer.—Preliminary Discussion of Three Year's Observations with the Cookson Floating Zenith Telescope: H. S Jones.—The Greenwich R—D System: W. G. Thackeray.—*Probable Papers*: A Determination of the Systematic Motions of the Stars from their Radial Velocities: A. S. Eddington and W. E. Hartley.—The Serious Effect of Suspension on the Rate of a Watch: J. J. Shaw.—Dates of Maximum of S Herculis: T. E. R. Phillips.

Institution of Mechanical Engineers, at 8.—The Distribution of Heat in the Cylinder of a Gas-engine: Prof. A. H. Gibson and W. J. Walker.

Malacological Society, at 8.—A Dibranchiate Cephalopod (Plesioteuthis) from the Lithographic Stone of Bavaria: G. C. Crick.—Description of a New Species of Zingis from British South West Africa: J. R. le B. Tomlin.—Diagnosis of a New Species of Dyakia: G. K. Gude.

Physical Society, at 8.—Precision Resistance Measurements with Simple Apparatus: E. H. Rayner.—Some Novel Laboratory Experiments: F. W. Jordan.—Electrically Maintained Vibrations: S. Butterworth.

SATURDAY, May 15.

Royal Institution, at 3.—Advances in the Study of Radio-active Bodies: Prof. F. Soddy.

MONDAY, May 17.

Royal Geographical Society, at 3.—Anniversary Meeting.

Victoria Institute, at 4.30.—Weights and Measures of the Hebrews: Prof. R. S. Kennedy.

Aristotelian Society, at 8.—Synthesis and Complexity (Bergson): Miss K. Costelloe (Mrs. Stephen).

Royal Society of Arts, at 8.—Foodstuffs: Dr. D. Sommerville.

TUESDAY, May 18.

Royal Institution, at 3.—Advances in the Study of Radio-active Bodies: Prof. F. Soddy.

Royal Statistical Society, at 5.

Royal Anthropological Institute, at 8.15.—Who were the Cliff-dwellers?: Dr. J. O. Kinnaman.

Illuminating Engineering Society at 8.15.—*Discussion*: Some Points in connection with the Lighting of Rifle Ranges.

WEDNESDAY, May 19.

Royal Meteorological Society, at 4.30.—The Wet English Winter of 1914–1915: Dr. H. R. Mill and H. E. Carter.—Report on the Phenological Observations for 1914: J. E. Clark.

Royal Society of Arts, at 8.

Royal Microscopical Society, at 8.—The Male Genital Armature of the Dermaptera: Dr. Malcolm Burr.

THURSDAY, May 20.

Royal Society, at 4.30.—*Probable Papers*: The Corpuscular Radiations Liberated in Vapours by Homogeneous X-Radiation: H. Moore.—The Absorption in Lead of γ Rays Emitted by Radium B and Radium C: H. Richardson.—The Application of Interference Methods to the Study of the Origin of Certain Spectrum Lines: T. R. Merton.

Royal Institution, at 3.—The Movements and Activities of Plants: Prof. H. Blackman.

Institution of Mining and Metallurgy, at 8.

Aeronautical Society, at 8.30.—Wilbur Wright Memorial Lecture—The Rigid Dynamics of Circling Flight: Prof. G. H. Bryan.

FRIDAY, May 21.

Royal Institution, at 9.—Beauty, Design, and Purpose in Foraminifera: E. Heron-Allen.

SATURDAY, May 22.

Royal Institution, at 3.—Colouring Matters of Nature: Dr. M. O. Forster.

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THURSDAY, MAY 20, 1915.

SCIENCE AND THE STATE.

IN the *Chemical News* of April 30 there is a very moderate article emphasising what has been frequently preached in vain: the necessity of a close connection between the public Services and men of science. It is argued that the present is a special opportunity of again advocating the necessity of intimate co-ordination of effort; the societies have ever been willing to render gratuitous service; the Royal Society, for example, has for long put at the disposal of the Government the knowledge and advice of experts in all branches of science. The writer of the article, however, directs attention to the comparative scarcity of young men trained in research, and points out that it is by no means easy for a young graduate to obtain employment otherwise than by teaching. To rectify this state of affairs, he suggests the foundation of research institutes, where such young men could find employment (remunerative, it is to be presumed). These institutes should, it is remarked, be directed by men of eminence in their own branches, free from the irksome duty of teaching. The writer of the article further points out that while the average quality of German research is not high, still its quantity is great; and that British inventiveness is relatively higher. It is questionable whether his statement holds that the result of the German methods of scientific education has been the production of men of resource, men who are able to act promptly and on their own initiative in emergency; this power he believes that we British lack in the present crisis. I do not agree; it is not that power in which we are deficient, but the faculty of organisation, where each man is willing to do only the share which is allotted to him. That is the essential characteristic of the German; he lacks originality, but is content to form a cog in a system of wheels directed from above. Nor are the brains of this human machine original; they have learned how to appropriate and render commercial the ideas of inventors, chiefly those of the non-Germanic nations.

The deputations to Mr. Runciman and Mr. Pease of members of the Royal and the Chemical Societies, and of the Societies of Chemical Industry and Analysts, reported on in NATURE of May 13 (p. 295), urged the appointment of a Standing Committee, serving the purpose of an intelligence department, and also helping the large and growing chemical industries of the country in the same way that the Commercial Intelligence Department serves merchants and traders. It was pointed out that the expansion of the chemical industries of the country requires co-operation between science and manufacturers, and that an increase in the number of research workers is desirable. The speakers also insisted on the need of a more intelligent appreciation of the significance of original scientific work by the Government. To these remarks Mr. Runciman and Mr. Pease made sympathetic replies.

On the evening of the same day on which the report appeared in NATURE, Mr. Pease announced in the House the intention of the Government to create an Advisory Council on Industrial Research—a committee of experts who would be able to consult with other expert committees working in different directions, and associated with leaders of industry. "He was now considering names."

Now, we do not doubt the good will of the members of the Cabinet, but we distrust their judgment in this matter. The handling of the dye scheme was, to say the least of it, very unfortunate. There are two German works, one the Mersey works, a branch of the "Badische," and one at Ellesmere Port, a branch of the German works at Höchst, which might have been associated forcibly with this combine with advantage to the country; moreover, the total lack of chemical talent on the directorate does not argue for its success, as the public has testified by failing to subscribe the issue. The two "eminent chemists" who advised the Government on the dye scheme doubtless do not thank the member of the Cabinet for their unsought publicity. These and other similar instances lead us to mistrust the judgment of Mr. Pease and his colleagues on questions involving science.

There is certainly room for a chemical council, and I had already prepared a draft scheme about two months ago, which has been submitted to, and has had the general approval of, several of our leading industrial chemists. Perhaps it might help were an outline of the scheme to be given here. It is headed "A Draft Scheme of a Chemical Council of State." The clauses are as follow:—

1. The dependence of the welfare of a country on its chemists is obvious. Chemistry lies at the basis of practically all manufactures. Continental nations and the United States have long acknowledged this.

2. Great Britain is behind no nation in the eminence of its chemists. But inducements are lacking to persuade young men to accept minor

positions. Chemical research, as indeed all research, is of two kinds; capital discoveries are made by some, and in this Great Britain probably leads. But the patient development of known ground requires men of a different calibre—men of more ordinary attainments; such men are lacking in numbers in Great Britain.

3. Men of the first rank exist both in the universities and in industry. It is of these that the Chemical Council should consist. About twenty men of this class could easily be named, of the highest reputation and of great experience. Among them every one of the numerous branches of chemistry could be covered; one or more of them would be competent to give expert opinion on every subject which falls within the purview of chemistry.

4. The manufacturing chemists in Great Britain are, generally speaking, not combined. It is true that the alkali-makers work on a mutual understanding; so do the ironmasters. But chemical products are so varied that it may be truly said that industrial chemists work in isolation from each other. It is also generally true that there is little contact between industrial and scientific chemistry. The teachers and students in universities and colleges know little of what passes in the world of manufacture, nor do industrial chemists, as a rule, consult the heads of scientific laboratories. This, again, does not obtain abroad.

5. A Chemical Council for the United Kingdom or for the Empire should comprise both classes of men: scientific investigators and those who apply scientific discoveries to industry. It should contain about twenty-four members, of whom one-third should be technical chemists, one-third scientific investigators, and one-third analytical and consulting chemists.

6. Its duties should be:—

(*a*) To ascertain from every chemical factory in the kingdom (1) the nature of its raw material; (2) the nature and amount of its finished products; (3) the nature of its by-products and what becomes of them. Also to learn by inquiry of the purchasers and users of chemical products—(1) what articles they obtain from home manufacturers; (2) what articles they purchase from abroad; and (3) the causes which induce them to encourage foreign rather than home industries.

(*b*) To establish connection with the chemical laboratories of universities and colleges, and to bring chemical researchers into contact with manufacturers, so that the latter should indicate to the former what problems await solution; and the former should keep the latter posted in any discoveries which appear to promise to be of technical value.

(*c*) To advise the Government on questions involving a skilled knowledge of chemistry and its applications.

7. It would not be desirable to enlist the services of the members of such a committee free of remuneration; a small annual retainer would, however, be sufficient to create a feeling of responsibility. It would, of course, be necessary for the Council to employ agents, who must also be skilled chemists, to carry out such work as visiting factories and interviewing the heads of departments both of factories and colleges; also some clerks and typewriters would be essential.

8. It would make for efficiency if a certain proportion of the members of such a committee were to offer themselves for retirement annually, as do the directors of a company. It would be open to the remaining members to recommend their continuance in office or their replacement by fresh blood. If the Council consisted of twenty-four, eight members might retire each year, with the possibility of re-election.

9. This Council would resemble to some extent a Royal Commission, but it should be appointed for a term of years, say ten, with the possibility of continuance as a permanent body should its work be successful. It must be remembered that the progress of science and its applications has no end.

10. The Committee should report once a year at least, or even at shorter intervals, to the Crown. It would appear advisable not to attach it to any Government department, but to associate it with the Board of Trade, the Board of Agriculture and Fisheries, the Local Government Board, the Board of Education, and also with the Government laboratories.

11. As it is clearly of advantage that such a committee should be non-political, it would be well if it were appointed by and were directly responsible to the Crown.

To whom is the nomination of the first members of such a committee to be entrusted? For on that will depend its success or its failure. I suggest that the President of the Royal Society, himself a most distinguished chemist, should be asked to nominate from the Fellows four persons, two scientific chemists and two technical chemists; and that they, under his chairmanship, should select the names of twenty other persons, themselves constituting four members of the Council. It is unlikely that Sir William Crookes could be prevailed on to add to his numerous onerous duties by himself serving on the Council; but he would probably consent to act as chairman of the electoral committee.

It is earnestly to be hoped that members of the Government will agree to adopt some such scheme. To embark without expert—real expert—advice on nominating the members of such a Council would be to expose it to risks equal to that attending the dye scheme, and would make it impossible to achieve the objects which they appear to have at heart. Let us hope that they will, in this case at least, trust the expert.

Lastly, it is earnestly to be hoped that Mr. Pease's good intentions will not take the form of the institution of a number of Government scholarships. It is grossly unfair to induce young men by scholarships to embark on a career which has little if no outlook; and that has hitherto largely been the case. The status of chemists in Government employment, for example, is not such as to induce any young man who can choose any other profession to devote himself to the career of an official chemist. Compared with other civil servants, he is underpaid and overworked. And although certain manufacturers, to their credit, maintain excellent laboratories, in which a young man has scope to show his ability and may meet with a suitable reward, yet these are the exception. It is to increasing their number and organising their resources that the efforts of the Chemical Council should be devoted.

The suggestion of the foundation of chemical institutes will not meet the case. Those at Dahlem, near Berlin, I am informed at first hand, are not appreciated by the young chemists who work in them; they do not lead to permanent positions. The same cause has resulted in the comparative failure of our Davy-Faraday Institution; and it would be futile to embark on an ambitious scheme for training research chemists without first making sure of their having a reasonable chance of earning a living when they leave.

WILLIAM RAMSAY.

A GREAT PLANT COLLECTOR.

Journal kept by David Douglas during his Travels in North America, 1823–1827. Pp. 364. (London: W. Wesley and Son, 1914.) Price 21*s*. net.

DAVID DOUGLAS, whose journals after lying neglected for nearly ninety years have recently been printed and published by the Royal Horticultural Society, was born near Scone, in Perthshire, in the year 1798. He was apprenticed as a gardener in the Earl of Mansfield's gardens at Scone. When he was about twenty years of age he went to the botanic garden at Glasgow, where at that time the elder Hooker held the position of professor of botany. He became Hooker's assistant and companion during his famous botanical tours in the western Highlands, and showed such a love and enthusiasm for plants that when the Royal Horticultural Society, in quest of a suitable man for a botanical expedition to North America, applied to Hooker, the latter at once recommended Douglas. Douglas accordingly visited the eastern United States and Canada in 1823. His journal describing this trip has but a mild interest, much of the ground he traversed having been already well trodden. He fulfilled his task, however, so much to the satisfaction of the Royal Horticultural Society that, in 1824, he was again dispatched to North America, this time to the western side. By reason of the number of plants he discovered and introduced this journey proved an epoch-making one, both in botany and horticulture. Douglas left Gravesend in July, 1824, and, going by way of the Straits of Magellan, reached the mouth of the Columbia River the following April. After two years' work in Oregon and California he returned by the overland route to York Factory, south of Hudson's Bay, and reached England in October, 1827. He made a second journey to the same regions in 1829, but of this the present volume gives no account.

Douglas stands undoubtedly in the very first rank of plant collectors, having as his compeers such men only as Masson, Allan Cunningham, William Lobb, Robert Fortune, and Wilson. The journals show that he possessed to a high degree those peculiar and diverse qualities that go to make a first-class plant collector—physical courage and endurance, contempt of hardships, a love and knowledge of botany, together with a certain business aptitude and adaptability to new surroundings. He enjoyed the advantage of a practically virgin field for his labours, for scarcely any botanical exploration had been done in this region since Vancouver's voyage of survey some thirty years before, when Archibald Menzies—Vancouver's surgeon and botanist—had made a few excursions near the coast. And not only was his field a virgin one; it comprised the finest sylva of temperate regions, one might even say, of the entire world.

These journals were written in simple style, often apparently after the day's journey was done, with no attempt at literary embellishment and agreeably free from any bombast or undue self-consciousness, such as has been too often characteristic of self-educated men of Douglas's class. It is not often even that Douglas indulges in a reflection on the marvels of nature, new and wonderful as they must have appeared to him. Much of what he records is little more than what has happened on previous days, and is going to happen on succeeding ones. Yet in spite of a certain monotony, the narrative possesses that charm and interest which mark even the plainest story of the pioneer. Douglas was apparently but seldom in danger from Indians or animals, although, with regard to the former, the situation became strained on more than one occasion. Grizzly bears, too, provide an occasional excitement, and we have a glimpse (p. 217) of one of Douglas's companions hurriedly climbing an oak, with the claws of an angry grizzly so close behind that his coat and trousers were torn to tatters. But, on the whole, it was storm and rain, cold, swollen rivers, excessive fatigue, and an insecure food supply that made up the chief hardships of his wanderings. The botanical interest of his writings is not so great as it would have been had the plants he met with and enumerates been identified. There is not so much to interest one in a paragraph like "(467) *Poa* sp.; annual; small, creeping; on the sandy banks of rivers, plentiful," as there would be if we knew the particular grass to which he was referring.

One of the most interesting items in the narrative is the collector's quest for a pine of extraordinary dimensions of which from time to time he heard accounts. His final success in exciting circumstances is recorded on page 230:—

"About an hour's walk from my camp I was met by an Indian, who on discovering me strung his bow . . . and stood ready on the defence. As I was convinced this was prompted by fear, I laid my gun at my feet and waved my hand for him to come to me, which he did with great caution. With my pencil I made a rough sketch of the cone and pine I wanted and showed him it, when he instantly pointed to the hills about fifteen or twenty miles to the south. As I wanted to go in that direction he, seemingly with much good will, went with me. At midday I reached my long-wished pine, and lost no time in examining and endeavouring to collect specimens and seeds. Lest I should never see my friends to tell them verbally of this most beautiful and immense tree, I now state the dimensions of the largest one I could find blown down by the wind: Three feet from the ground, 57 feet 9 inches in circumference; 134 feet from the ground, 17 feet 5 inches; length, 215 feet."

The editor gives no indication of what this tree proved to be, but from the description we have no doubt that Douglas here describes the first discovery of that most wonderful of pines, *Pinus Lambertiana*. He was not permitted to get away from the spot unmolested, for in bringing down the cones with shots from his gun the reports brought some armed and painted Indians on the scene, and it was only after some hazardous moments and a combination of palaver and display of pugnacity that Douglas escaped with but three cones and a few twigs.

Where a plant is mentioned by Douglas under a name which is not now accepted, the editor has given its modern equivalent in a footnote. This, of course, is helpful in many instances, but where the collector was palpably in error the fact might have been pointed out. Douglas was in a new country, but he often erroneously assumed that a plant he found on the western side of America was identical with one he already knew on the eastern. A novice is thereby led to believe that *Abies balsamea, Pinus Strobus, Tsuga canadensis, Amelanchier canadensis, Picea rubra,* and several more eastern trees are to be found in Oregon or California.

We are given a portrait of Douglas (showing a mild but Napoleonic cast of countenance), but in reading the book one feels very much the need of a chart giving an indication of his itinerary. Some of his place names are not discoverable in the atlas. Considering the book is published at the not ungenerous price of one guinea net, we think this addition might reasonably have been made. In a series of appendices are given a brief memoir of Douglas, an account of some ascents of the mountains in the Sandwich Islands, a list of the plants he introduced, and an account of his early and tragic death at the age of thirty-six in the Sandwich Islands, where he fell into one of the pit-traps made to catch wild cattle, in which an infuriated animal was already entrapped.

APPLIED CATALYSIS.

The Hydrogenation of Oils, Catalyzers, and Catalysis, and the Generation of Hydrogen. By C. Ellis. Pp. x+340. (London: Constable and Co., Ltd., 1914.) Price 16*s*. net.

THE catalytic reduction of unsaturated carbon compounds by the direct action of hydrogen in the presence of a finely divided metal may be said to have been discovered by v. Wilde in 1874, when he succeeded in transforming ethylene into ethane by passing the unsaturated hydrocarbon mixed with hydrogen over platinum-black. Although this reaction was found to be of considerable service in synthetic chemistry, it remained without special significance until Sabatier and Senderens started their epoch-making researches in 1897. These chemists found that finely divided metals other than platinum, namely, iron, cobalt, copper, and especially nickel, could be used with marked success as catalysts in reactions of this type, and the catalogue of Poulenc Frères, of Paris, bears witness to the practical success which has attended their work.

It is stated that the nickel most suitable for the purpose is obtained by reducing the oxide by hydrogen at a temperature of between 270° and 300°, but no one who has worked on this subject can have failed to experience the extraordinary differences in the activity of the metal produced under various experimental conditions, and it is therefore not surprising that no great technical use has been found for the process until within comparatively recent years.

The fact that the liquid or unsaturated fats of the olein type are unsuited for the purposes of soap-making, as well as for the production of edible fats, has caused numerous experiments to be made with the object of converting these substances, either wholly or partially, into the saturated or hard fats of the stearin series. As early as 1875 Goldschmidt showed that oleic acid could be reduced to stearic acid by phosphorus and hydriodic acid at a high temperature, and, indeed, this process, or a modification of it, was applied on the industrial scale at about this time, but the method was not successful, and it was not until W. Normann, in 1903, took out a patent for a "process for converting unsaturated fatty acids or their glycerides into saturated compounds" that the Sabatier and Senderens' method was applied to the saturation of unsaturated fats and the tremendous possibilities of the process from an industrial point of view became evident.

The patent of Normann was obviously bad, and it was rendered invalid in 1913, as the result of an action between Joseph Crosfield and Sons, Ltd., and Techno-chemical Laboratories, Ltd.

In the book under review, the first two chapters are devoted to a description of all the various processes which have been used for the purpose of effecting hydrogenation, and it is in this portion that the author seems to have erred on the side of over-elaboration. The point had evidently occurred to him, because, in his introduction he states that "The observations and opinions of many minds have been brought together. Some of these views obviously are sound, others are open to grave doubt, and still others are of a contradictory or polemical nature. Whether or not in the treatment of this material to carry through a vein of critical comment was a problem which confronted the author." That he decided not to introduce this vein of criticism and to give the value of his experience in discriminating between the various processes is, we think, a matter which will be regretted by the average reader. As it is, one almost feels inclined to say that some of the methods described could scarcely have been expected to yield satisfactory results even by their discoverers, and the reader who is not an expert will arrive at the conclusion that there are some fifty different ways by which hydrogenation may be accomplished, and that all of them are of equal importance. To the expert, however, who is able to sift grain from chaff, this section will be of the greatest service.

The same criticism applies to the next section of the book, which deals with the various kinds of catalysers which have been used. This section occupies two chapters, and is succeeded by an admirable account of nickel carbonyl, followed, in chapter vi., by an interesting account of the work of Paal and others on the use of the rare metals in the colloidal state as catalysts. Chapter viii. deals with the analytical constants of hydrogenated oils, and the two succeeding chapters contain a description of the methods by which these oils may be converted either into edible fats or into soap. The last nine chapters of the book, some hundred pages in all, deal with the various methods which have been devised for the preparation of hydrogen. This section is treated in a most exhaustive manner, and the influence of impurities in the hydrogen, acting either as poisons to the catalysts or as substances injurious to the oils, are discussed. The book ends with an appendix containing an account of the recent litigation over the Normann patent.

This excellent treatise is well illustrated by some 145 photographs and drawings both of scientific apparatus and of plant. The admirable manner in which the author has emphasised the scientific basis of the technical processes which he has described causes it to be a noteworthy addition to our literature on specialised organic chemistry.

J. F. T.

A TEXT-BOOK OF EFFICIENCY.

Fundamental Sources of Efficiency. By Dr. F. Durell. Pp. 368. (Philadelphia and London: J. B. Lippincott Company, 1914.) Price 10*s*. 6*d*. net.

TO many it once came as a shock to hear that the great Mach laid stress on the economy of thought in science. It seemed as though science were brought into too close analogy with much more mundane kinds of human activity. But in this book the study of almost every conceivable kind of activity, including scientific activity, is made from the abstract point of view of efficiency. "An efficient process is one in which the available results exceed the expenditure" (p. 4); and the work is an attempt to analyse the various forms and sources of efficiency into a few elemental principles. "While the book has been cast in a form adapted to general reading, groups of exercises have been inserted which, it is hoped, will add to its value if it is used as a text-book in any institution where the principles of efficiency are taught."

Surely it is only in America that we could have a professor of efficiency. From the preface we also learn that, since the importance of investigating the elements which constitute fitness, that is, efficiency, becomes evident as soon as the principle of the survival of the fittest is recognised, the leading ideas of the book were suggested by the reading of Herbert Spencer. Many important details have been obtained from the publications of the Efficiency Society and the works of various modern writers.

The most primitive and, in a sense, fundamental source of efficiency is the act of re-use or repetition, and human progress in general is marked by an increasing amount and by higher forms of re-use (p. 31). A superior efficiency to more or less haphazard re-use is attained by the "unit and multiplier principle" treated in chapter iii.: "A *unit* is any entity used manifoldly in space or time or in any relation. The *multiplier* expresses the number of manifold uses made of a unit" (p. 50). This principle may be extended so as to form a still more general agent of efficiency, that of the "group," and this is dealt with in chapter iv. The group is so fundamental in its nature that the other primal sources of efficiency may be regarded as various methods of using the group. Groups may be used not only singly, but also in combination, with a corresponding increase of efficiency (chapter v.). It is often a source of efficiency to substitute for a given system of groups a series of groups or "orders" of the system (chapter vi.). The use of an object or objects external to a given domain as a means of obtaining results by forming new and large groups is the source investigated in chapter vii.

Chapter viii. deals with sources obtained by the perceptions of diversities and of uniformities. After a study (chapter ix.) of the aims and ends of efficiency processes, chapter x. contains a good treatment of symbolism as an agent of efficiency, and here pp. 174–175, 177, 185, 187 (*cf.* p. 359) seem especially noteworthy. The other chapters are on the principle of directive action, the study of speed and rhythmic methods as means to efficiency, the principle of "dialectic" or unexpected discovery, the study of limitations of processes, the removal of waste and error, and the combinations of efficients. Chapter xviii. deals with applications to psychology, education, sociology, business, art, ethics, and religion. Finally, there are appendices on "The Categories and a General Philosophy of Life" and a "Historical Survey."

The book is rather obscurely written, but contains very much valuable illustrative material.

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OUR BOOKSHELF.

Elementary Human Biology. By J. E. Peabody and Dr. A. E. Hunt. Pp. xii + 194. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 4*s*.

UNDER this somewhat curious title the two authors, American schoolmasters, have produced a manual which deals with elementary hygiene. It is evidently written for children, for the pronunciation and derivation of comparatively simple words, such as involuntary and ventilation, are given. It, however, manifests a curious lack of perspective, for while it contains simple exercises which teach young pupils the reasons for rules of health, such as cleaning the teeth, masticating the food, and washing the skin, it also deals with elaborate details for comparing bacteriologically with Petri dishes the air of a room after sweeping it with a broom, and after the use of a vacuum cleaner. One home exercise which with unconscious humour is marked optional consists in chewing popped corn and noting that it becomes sweet during the process. The conditions of American life are so often different from those in this country, for instance, in the matters of heating and ventilating houses, that we doubt whether the present book will profitably replace the many excellent text-books on hygiene we already possess here; the same may be said in relation to subjects such as profitable housekeeping and cooking. Even if the English child or his parent overcomes the difficulty of converting dollars into shillings, we doubt whether they will be much enlightened by such words as skillet, round steak, and string beans.

A few of the many errors noted are: that milk-sugar is changed into grape-sugar by heating it with Fehling's solution; that the saliva forms dextrose from starch; that nerve impulses travel 100 ft. per second; that Nissl granules in nerve cells appear as a result of fatigue; that the epiglottis closes as a lid on the larynx during swallowing; that peptone is the end-product in digestive proteolysis; that Sylvester's method for artificial respiration is the best. Children, it is true, require teaching to be simple, but they deserve that it should be accurate. W. D. H.

Inorganic Plant Poisons and Stimulants. By Dr. W. E. Brenchley. Pp. ix + 110. (Cambridge: At the University Press, 1914.) Price 5*s*. net.

MISS BRENCHLEY has set herself a difficult task in attempting to deal with problems such as are indicated in the somewhat ambitious title of her book, and we confess to a feeling akin to disappointment after a perusal of the volume. The work is good as far as it goes, but the treatment is less suggestive, and the grip less firm than we had been led to anticipate.

The effects of the salts of five elements, viz., copper, zinc, arsenic, boron, and manganese upon plant growth have been studied, and the surprisingly deleterious results which follow on the addition of minute traces of some of them to plants grown as water cultures are described, and are also illustrated by excellent photographs. The conclusion is reached that no stimulation of growth follows the addition of even the smallest amounts of salts of copper, zinc, or arsenic, whilst some improvement does occur when salts of boron or manganese are employed. This is of interest when the somewhat widespread notion of the beneficial action of traces of copper salts, in some instances, at any rate, is recalled. Naturally, however, one must accept with caution conclusions based on the results of water-culture experiments in any endeavour to extend them to plants growing under ordinary soil conditions. This is the more necessary when one reflects how differently plants may behave in pot culture and in the field, and that even in the field itself it is not possible always to predict results at all accurately when the soil, aspect, drainage, and other factors as well are all subject to variation. We need a far more intimate knowledge of the physical conditions, as well as of the chemical processes that are in part, and often largely, governed by those conditions in the soil, before we shall be in a position even to formulate these fundamental questions, a satisfactory answer to which must form the basis on which our real knowledge of the plant, in this connection, will have to be built up. Miss Brenchley is fully aware of the difficulties which surround the whole subject, and her summing up of the whole position is admirable in its caution.

Index to Periodicals. Compiled by various authorities and arranged by A. C. Piper. Vol. i., April—September, 1914. Pp. xxxii + 192. (London: Stanley Paul and Co., for *The Librarian and Book World.*) Price 21s. net.

The general editor of this classified and annotated index to the original articles contained in some of the principal weekly, monthly, and quarterly periodicals, Mr. A. J. Philip, rather disarms criticism by recounting in the preface the difficulties due to the war under which the index has been prepared. The idea of such an index of the important signed articles in periodical literature was excellent, and had it been possible to carry it out with some completeness, the result would have been widely welcomed.

It is difficult to understand on what plan the 109 periodicals indexed have been chosen. The preface says that foreign periodicals have been omitted, yet the names of a few appear in the list of those indexed. The *Journals* of the Royal Anthropological Institute, the Royal Microscopical Society, the Royal Sanitary Institute, and the Royal Statistical Society have been dealt with, but the publications of the Royal Society, the Royal Astronomical Society, the Royal Meteorological Society, the Chemical Society, the various engineering institutions, and scores of others of equal importance are ignored. Similarly in education, attention is confined apparently to the *Educational Times*, the *Journal of Education*, and the *Parents' Review*, while no mention is made of the *Preparatory Schools Review*, the *School World*, the *Schoolmaster*, and a host of others. The *Classical Review* is indexed, but the periodicals concerned with modern languages, English studies, nature study, and so on, seem to have been forgotten.

While appreciating the enterprising beginning which has been made, it may be hoped that in the next volume the compilers will cast their nets more widely, and so secure a more representative production.

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 National Organisation of Scientific Effort.

For readers of Nature one of the most striking features of the war is that the German Government should be approved and supported by its prominent men of science, in spite of the fact that it uses methods of warfare which we regard as being outside the pale of humanity and common civilisation. It seems inconceivable that anything like it should happen in this country. If the British military authorities had transgressed against the written and unwritten laws of humanity as Germany has done, we feel sure that our men of science would have found a voice in condemnation of the Government. In this country it is no unusual thing for men of science to find a voice in condemnation of the Government, both for what it does and for what it leaves undone. Such condemnation used, in fact, to be, in peace time, a staple article of scientific public-speaking, the like of which one did not find in Germany. One never heard there even in private conversation the kind of criticism of Government action or inaction which in this country is reiterated commonplace.

The difference in practice may be attributed to the fact that in Germany scientific effort is organised by Government, which stands to scientific work in the relation of creator, provider and guardian, on its own terms. In Germany, Government is the providence of science; and to rail against Government, even when its ways are dark and mysterious, is not to be thought of. The attitude of the man of science in Germany towards his Government recalls Cowper's hymn. Changing the grammatical gender to avoid irreverence:—

> Blind unbelief is sure to err
> And scan Its work in vain,
> It is Its own interpreter
> And It will make it plain.

We have nothing like it in this country, and this reflection prompts the question: What is the corresponding organisation in this country? For organisation there must be, whether it be simple or elaborate, effective or ineffective, intentional or haphazard.

Our organisation is, in fact, haphazard, a matter of history and tradition; and, on examination, it will be found to be at least moderately efficient as regards persons, but woefully inadequate as regards subjects.

The difference is well pointed by an incident at a dinner in connection with a scientific meeting a few years ago. The speaking, after dinner, had become rather informal, and one of the foreign representatives urged the desirability of a professorship in, say, seismology—the particular subject is unimportant—and, in reply, the chairman said that he had recognised the need for a long time, and was uncertain whether the best way of approaching its satisfaction was to appeal directly to the universities, or to begin with the schools and so create a demand which the universities would find it to their interest to meet. The German representative on leaving the dining-room remarked: "But, of course, *your Government* must create a professorship." The only reply to that is that it is not our way.

Then what is our way? To what authority in this country does one appeal for the promotion of the study of any scientific subject which is felt to be in want of support?

There is the Royal Society, which is known to be a remarkably powerful body for discriminating between the merits of the scientific workers in this country. Some years ago one of its presidents devoted a series of presidential addresses to the claims of science in education; but to ask the Royal Society to put machinery in motion to supply the need for university professorships in certain subjects would be simply to court a rebuff, and for an obvious reason. It is understood that the Royal Society, though it is, for some purposes, a representative body, does not regard itself as the proper body to take the initiative in approaching the Government for the support of a new scientific project. The proper course is supposed to be for those who are interested in the project to approach the Government themselves, and for the Government to refer the matter to the Royal Society as a kind of jury. By that mode of procedure the promoters, without the official support of the representatives of science, have first to convince the Government that their project comes within its province, a task that in itself is enough to damp the ardour of many enthusiasts.

If the Royal Society is shy of approaching the Government, it would be still more shy of approaching directly an academic corporate body. That is not to be thought of. Besides, it is itself academic enough to know the answer without going through the formality of making the inquiry.

Nor is it likely that an avenue to the purse of the private benefactor could be found through the corporate action of the Royal Society, although without such action any appeal is prejudiced from the start. It can scarcely be doubted that if the Royal Society would from time to time set out the gaps in the professorial ranks of the universities on account of subjects of deep human and scientific interest which have no exponents in the academic life of this country (and so, by conscious or unconscious imitation, of the British Empire), the appeal would carry conviction to some of those who are willing to consider a worthy outlet for part of their wealth. The contention that the British Empire is not rich, or at least not rich enough to staff its universities properly, will not really bear examination; and yet the very dignity of the Royal Society seems too great for it to undertake the duty of appealing for funds for separate subjects that need support.

So we are back again at the usual refuge for science in distress: the Government. The front door is closed, as we have seen, but we can try the back.

Let us concentrate our attention on the "research" aspect of the question and appeal for support to the "Government grant for scientific research" which is administered with a free hand by a committee appointed by the Royal Society. It is common knowledge that the committee acts ostensibly on the principle that for research in this country all that the Government needs to provide is a number of small doles to enthusiastic workers who find themselves deficient in apparatus and materials. The sums necessary for the maintenance and remuneration of these workers have to be provided by other means—into which the Government Grant Committee is careful not to inquire.

But with the neglected subjects to which we have been referring, research has to be initiated and workers found and paid: the Government Grant Committee draws the line there. It is a very unfortunate conclusion, because any appeal to Government for research from anybody but the Royal Society can be, and indeed is, rightly estopped by a reference to the provision which already exists for scientific research, and which is not officially known to be inadequate.

Here again the Royal Society shows itself admirably efficient in discriminating between the merits of the persons who apply for the doles, but it has practically nothing to say to the appeal for subjects left entirely in the cold.

Is it unjust to sum up the situation with regard to the subject-aspect of our national organisation of scientific effort by saying that it is in this unfortunate position: that on the one hand nothing can be done without the Royal Society, and on the other hand, with all respect and admiration, nothing can be done through the Royal Society?

Yet things are done from time to time; ways out of the dilemma have been found; our existing organisation must have other aspects. Parenthetically it is a matter for wonder how the subject of mineralogy came by the provision which it now enjoys at the older universities. One has the feeling that if it had not been endowed long ago it would never be endowed now. It seems even further from the important consideration of the "main chance" which appeals to the universities than some other subjects which have still no academic status.

Looking back at the history of the other subjects which may be included in the title of out-of-door physics, we find that the British Association for the Advancement of Science stands out as the specialised organ of our national organisation for giving things a start. One knows the mode of procedure quite well. Certain prominent men of science (who when they are back in London will be the Royal Society) meet in some provincial town, discuss the matter, appoint a committee, and make a grant out of the members' pounds for out-of-pocket expenses. The subject prospers by the unpaid work of some indefatigable member of the committee; after some years an appeal is made to Government. The British Association conducts the appeal, which is thereby guaranteed respectful consideration; and its reception by the Royal Society jury is also guaranteed by the *personnel* of the committee; there is no element of danger in the reference, and so the plan is brought to some sort of fruition.

To the operation of the British Association can be traced the origin of what provision there is (outside the Royal Observatories, the Hydrographic Department of the Navy, and one division of the Meteorological Office) for meteorology, terrestrial magnetism, solar physics, seismology and the so-called "Standardisation" of instruments, now represented by the National Physical Laboratory. For each of these one or more committees of the British Association could be named, one of which dates as far back as 1842, early days even for the British Association. There are, no doubt, many other enterprises in other branches of science which have a similar history.

So the organisation of scientific effort on our side which corresponds with the Government organisation of Germany may be expressed by this precept for anyone who has a project for scientific work: "You first attend a meeting of the British Association and get a strong committee appointed; then you work for a number of years without pay, but with a mind conscious that you will thereby acquire merit with the Royal Society, the great discriminator; then if you have not money enough to pay for apparatus you can appeal to the Government Grant Committee with an assured prospect of success; then when you find it necessary for somebody to be paid, you can move the Council of the British Association to approach the Government for the money. The Government will then take the opinion of the Royal Society, and that will be quite all right, because your own committee will be in force there; and then, if you are moderately fortunate, Government will give you half of what you ask as a 'grant in aid,' and for the rest you must look out for yourself."

We are therefore by no means devoid of organisation; what we have is almost venerably historic and very elaborate; but it is long and tortuous and sadly inefficient for the following obvious reasons:—

First, that in spite of our pride in private effort, and our prejudice in its favour as being vastly superior to anything that Government can do, our process leads ultimately to Government and nowhere else. It gives no footing in the universities or in any other body, corporate or incorporate, whose members control the temporary destinies of the British Association. Of course, at the end of the chapter the Government could approach the universities, but with the present relations between Government and the universities this is a perilous thing for a Government to do. It was done in one instance lately; and there is "a smile on the face of the tiger."

Secondly, it leads to accepting Government money in the form of what is called a "grant in aid," which means public money with public responsibility, but no official prestige and no official purpose. The grant is made as a concession to somebody's enthusiasm; the responsibility for success rests with the unfortunate enthusiast, and the limitation of ways and means rests with somebody else. One of the common forms of our scientific attitude is that Government support chills and discourages private effort. The scientific societies are fond of adopting it because it leaves them in a sort of control of things; and, of course, Government "as at present advised" is not likely to demur. But what attracts and stimulates private effort is really efficiency, whether public or private; it is frequently the case that support by Government lacks that stimulating quality simply because it represents not a purpose, but a concession. The situation recalls a remark once heard at a college dinner-table, when a country clergyman thus expressed himself concerning the Nonconformist discontent about education: "I cannot see what these dissenters have to complain of; we *tolerate* them." So with our national organisation of scientific effort: it ends in toleration by the Government, and the "establishment" looks on with a sort of bewildered wonder at our insatiable discontent.

Among the changes which will follow the war, whatever the issue may be, the reorganisation of scientific effort must find a place. All the after-dinner speeches about the parsimony of the Treasury, and all the complaints in *Science Progress* and at the meetings of the British Science Guild, punctuated by what has been brought to light since the war began, mean at least that.

We may learn from our enemies and let the Government take over the control of our scientific effort, or, appalled by the result in the case of Germany, and sharing the feeling of Prof. Brants and the Dutch for whom he speaks in the March number of the *Nineteenth Century and After*, we may have the courage to be ourselves and manage things in our own way. The future will show; only we must have a way which is recognisable and recognised. Behind the Government, whether in association with a special Minister or not, there must be a powerful advisory committee with facilities for initiation as well as discrimination, a sort of Privy Council for Science with public responsibilities, to whom the public as well as the Government can appeal.

Before that can be established the Royal Society must settle what its function is to be. At present it claims to discriminate in its corporate capacity, and leaves to its individual members the duties of initiation. The British Science Guild has sought to remedy this state of affairs, and is prepared to take the initiative in an organised way. But it is evident that, if the Royal Society is to exercise the power of discrimination, the two bodies must be in reality the same persons, as in the case of the initiative of the British Association, or the scientific body politic will be divided against itself; therefore the first question to be settled is whether the Royal Society's claim to the power of discrimination is to be confirmed and supplemented by the faculty of initiative, or whether both faculties are to be vested in a recognised and responsible body of Government advisers.

The Royal Society is by no means an ideal institution for the purpose, and it was not created for such work; its full body of four hundred and fifty members is too numerous to carry the responsibility, and its Council of twenty-one too small, too much selected for the purpose of personal discrimination, too transitory, too full of work of other kinds, too much unpaid, and not sufficiently representative of the subjects with which a national organisation must deal in the long run because they are not adequately represented at the universities.

The point is obviously a difficulty; but in the long last it can only be settled in one way, and the sooner the Royal Society takes the field with a proposal for an initiating and discriminating advisory body other than its own Council the sooner will it be possible to take a definite step in the direction of the national organisation of scientific effort. F.R.S.

Osmotics.

In connection with the recent discussion, at the Faraday Society, on osmotic and vapour pressures, it seems worth while to state that a long and laborious series of vapour pressure measurements which Mr. Hartley and I have undertaken is nearly completed, and I hope will be published shortly.

The results so far go to show that by taking $RT=22\cdot3909$ (in litres and atmospheres, and with $O=16$), which is the value for nitrogen and close to that derived from water vapour at 30° C., a very good agreement is obtained between the direct and indirect values of the osmotic pressure of cane-sugar at 0° C., and incidentally of calcium ferrocyanide.

I also take the opportunity of mentioning that if p be the osmotic pressure, V and v the volume of solution and volume of water containing one gram-molecule of cane-sugar, respectively—both being measured when compressed to the osmotic pressure—then $p(v-bv/V)=RT$ is found to give a fair fit to the results both at 0° C. and at 30° C.

A closer approximation is obtained with

$$(p-a/v^2)(v-v/Vb)=RT,$$

in which case the same constants give the values of p for both 0° C. and 30° C.

I also find that a somewhat less good fit is obtained from $(p+a/v^2)(v-vb/V)=RT$; this last equation, however, has the advantage that it gives a value of V when $dp/dV=0$, which, assuming that this point is the limit of supersaturation, we know is about right; that is, V is greater than the molecular volume of cane-sugar in the solution, and less than its value in a saturated solution, *i.e.*, a solution containing about 960 grams per litre at 30° C.

I would reserve the discussion of the meaning of these equations and others, which I have also obtained, until our final results are published.

BERKELEY.

Foxcombe, near Oxford, May 15.

A Bibliography of Fishes.

THE time is ripe—and has, indeed, long been ripe—for the publication of a carefully prepared bibliography of fishes, to cover the entire range of the subject: fishes fossil as well as living, and fishes from many points of view, such as anatomy, physiology, embryology, pathology, parasitology, distribution, taxonomy, everything, in short, excepting matters which deal with clerical details of the fisheries. Such a compilation, it is clear, means much for this branch of zoology, for the literature of the fishes is vast, widely scattered, and ill-digested. In fact, I believe that there is scarcely an investigator to-day who has not been obliged, needlessly, to give weeks or months of his time to searching for references.

The importance of such a bibliography was brought home to me about 1890; at that time I began the work of collecting references to be used in my studies, and as years passed I was able to build up a card-catalogue giving author and subject, which proved indispensable. Later my catalogue became known to correspondents, who in turn found it of use in their studies; and they, for their part, were generous in contributing references, and thus added notably to its value. It next, through the kindness of the Smithsonian Institution, absorbed the bibliography which Prof. Goode undertook to publish, and which his death left unfinished. Thus the value of the work became greater year by year. About 1910 the American Museum of Natural History allowed me secretarial help in the direction of editing the catalogue for publication. And thereafter, for about a year and a half this secretarial work was carefully carried on under the supervision of my colleague, Dr. Louis Hussakof, and since 1914 by Dr. C. R. Eastman, of the American Museum.

The scope of the undertaking may be understood when one considers that nearly 50,000 references are brought together. These have been gathered from all sources, notably from all accessible bibliographies, serial publications, and book catalogues. Finally, the effort was made to complete the lists of titles by bibliographies secured in so far as possible from authors themselves. To this end circulars were sent out to several hundred writers on ichthyology, many of whom responded cordially.

There still remain, however, a number of individual writers who have not contributed the titles of their publications. I have, accordingly, been led to publish the present note in the hope that any who have not already sent to Dr. Eastman or myself their bibliographies, may be reminded that we are especially anxious to make the work as complete as possible. We urge that their lists be sent in without delay, for the work is undergoing its final revision, and the first volume is shortly to go to press. This is the "author's" volume, which will consist of about 1000 pages, and include under the names of writers a serial list of their publications. The second, or "subject" volume, will be a classified index of the titles in vol. i. Here one has access to special papers in the various branches; for example, in anatomy, distribution, embryology.

BASHFORD DEAN.

American Museum of Natural History, New York.

The Use of the Term "Pinacoid" in Crystallography.

CAN any of your readers help me as to the original definition of the familiar term "pinacoid"? I suspect that it was introduced by C. F. Naumann about 1830; it was derived from πίναξ, a slab, and appears from the first to have included two parallel planes. Naumann, for instance ("Anfangsgründe der Krystallographie," 1841, p. 126), uses "basal pinacoid" for the pair of planes parallel to the two lateral crystallographic axes. But he restricts the use of pinacoid to the three possible pairs in a crystal that cut only one of the three axes, and (p. 19) defines a pinacoid as including "two parallel planes which are parallel either with the base or one of the other co-ordinate planes."

In 1856 we find Tennant and Mitchell ("Mineralogy and Crystallography") using pinacoid for a single plane of any of these pairs, and this, which is clearly a mistake, has been followed by writers of very recent date. Story-Maskelyne ("Crystallography," 1895, p. 20) agrees with Naumann, calling the single plane a "pinacoid plane." This latter fact has not been observed by the authors of the Oxford Dictionary. P. Groth ("Physikalische Krystallographie") in 1876 and 1885 employed the term in Naumann's way; but in his third edition of 1895 he introduced the term "pedion" (p. 337) for any single plane, and defined a pinacoid (p. 340) as consisting of any two parallel planes.

This extension of the term pinacoid from Naumann's original usage has been adopted by Lewis, Liebisch, Miers, and Tutton in their authoritative works. The pinacoids parallel to the three co-ordinate planes are thus left without a distinctive title, and in my own small "Outlines of Mineralogy" (1913) I have styled them "principal pinacoids." If the history of the matter is as I have traced it, it would seem better if Groth had invented a new term, side by side with pedion, rather than, as was so often done by Rosenbusch in the nomenclature of rocks, employed a well-established term in a new signification.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin, May 11.

A Mistaken Butterfly.

A FEW summers ago I noticed a fine cabbage butterfly executing a number of gyrations in front of a milliner's shop in New Bond Street, and making every effort to get through the plate-glass window. Immediately inside the window was a lady's hat (or bonnet, I am not sure of the distinction), ornamented by an enormous artificial scarlet poppy. It was quite clear that the object of the butterfly's attention was the poppy. Apparently he was guided by sight, and not by smell.

EDWARD A. MARTIN.

Grange Wood Museum, South Norwood, May 12.

ETHNOGRAPHIC STUDIES IN MELANESIA.[1]

THE two volumes of "The History of Melanesian Society," by Dr. Rivers, represent two methods of the study of mankind, the ethnographical and the ethnological. The first volume is devoted to an ethnographical study of a considerable portion of southern and central Melanesia and of various Polynesian islands; the account of Tikopia is of especial interest, as, although situated in Melanesia, it is inhabited by Polynesians, who have scarcely been affected by external influences. Most of the data were collected under the auspices of the Percy Sladen Trust. In the second volume the author breaks new ground in ethnology, as he synthesises and gives explanations of an even wider array of facts than those accumulated in the first volume.

Those who are acquainted with the previous writings of Dr. Rivers are well aware that, whether recording new facts or correcting and expanding information acquired by others, he has always paid great attention to method; indeed, he has perhaps done more than anyone else in this country to establish ethnology on scientific methods. It is interesting to note that until he began writing the theoretical discussion in the second volume, he was a firm adherent of the current English school, being almost exclusively interested in the evolution of belief, custom, and institution, and paying little attention to the complexity of the several cultures. He came to see, however, that Melanesian culture was more complex than had at first appeared, and that it was necessary to dissect out, so to speak, the associated elements in each of the component cultures.

Graebner was the first to study this problem systematically, but he approached it from the point of view of the museum curator without experience as a field ethnologist. Dr. Rivers states that the chief aim of his book "has been to show how social institutions and customs have arisen as the result of the interaction between peoples, the resulting compound resembling that produced by a chemical mixture in that it requires a process of analysis to discover its composition. To Graebner, on the other hand, the process of blending of cultures resembles rather a physical mixture in which the component elements exist side by side readily distinguishable from one another. . . . . He assumes that social institutions and religious practices can be carried about the world and transplanted into new homes as easily, and with as little modification, as weapons and implements. . . . Such an assumption is impossible to anyone who appreciates the far more vital and essential character of the less material elements of culture" (ii., p. 585).

By means of the genealogical method Dr. Rivers has discovered several remarkable forms of marriage in Melanesia, or has deduced forms which have existed previously. For example, cross-cousin marriage (*i.e.*, between the children of a brother and those of his sister) occurs in widely separated parts of Melanesia, and wherever found is accompanied by features of the systems of relationship which are clearly the direct result of this form of marriage; these features are found in places where cross-cousin marriage does not now take place, but they must certainly be survivals of it. The same applies to marriage with the wife of the mother's brother. The extraordinary system of the island of Pentecost owes its special features to two anomalous forms of marriage which either still exist or have been practised on the island, viz., marriage with the wife of a mother's brother, and with the granddaughter of the brother. For the latter, there

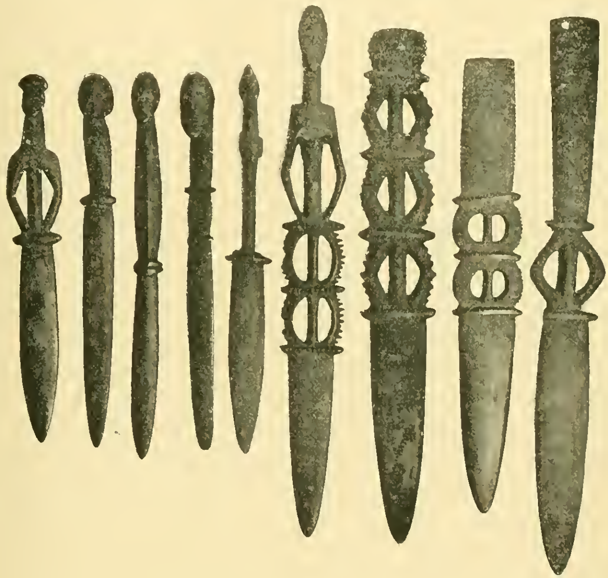

FIG. 1.—Pudding-knives from Ureparapara, Banks Islands. From "The History of Melanesian Society."

[1] "Percy Sladen Trust Expedition to Melanesia. The History of Melanesian Society." By W. H. R. Rivers. Vol. i., pp. xii+400; Vol. ii., pp. 610. (Cambridge: At the University Press, 1914.) Price 36*s*. net two volumes.

is a clear tradition of its occurrence in the past, and it is said still to be practised. This form of marriage also takes place among the Dieri of Australia, who recognise that relatives belonging to generations twice removed from one another are naturally husband and wife (ii., p. 47). Dr. Rivers will be interested to learn that Sarat Chandra Roy, in his forthcoming book on the Oraons of Chota Nagpur, will produce evidence to show that there are "reasons for inferring the former existence amongst the Oraons (before clan exogamy was instituted) of a system of marriage or union between persons related to each other as grandparent (or grand-uncle or grand-aunt) and grandchild (or grand-nephew or grand-niece)." These archaic social institutions may be preserved in nomenclature like flies in amber. Dr. Rivers argues that the anomalous forms of marriage imply a dual organisation with matrilineal descent, and he is driven to assume a state of society in which the elders had acquired so predominant a position that they were able to monopolise all the young women. He also points out that, according to this view, cross-cousin marriage arose as a modification of the marriage with the wife of the mother's brother.

FIG. 2.—Canoe and canoe-shed, Tikopia. From "The History of Melanesian Society."

Dr. Rivers has made a special study of the secret societies of Melanesia, and he works out an elaborate argument to show that the secret ceremonial is derived from rites brought by an immigrant people, relatively few in number, who were solely of the male sex, or accompanied by very few women of their own race. By considering the distribution and the customs and objects associated with betel-chewing and kava-drinking, he shows that these comestibles mark two main migrations into Melanesia, which previously was inhabited by a people with a dual organisation. Various methods of the disposal of the dead indicate racial complexity, and a study of each mode combined with associated data leads to a finer analysis. His conclusions may be summarised as follows:—

The introduction of betel-chewing was relatively late and restricted and may have taken place from Indonesia after the invasion of the Hindus. With it were associated marriage with the wife of the father's brother, the special sanctity of the skull, and the plank-built canoe.

The effect of the kava-using peoples was more extensive in time and space; they had neither clan organisation nor exogamy, some preserved the body, and respect was paid to the head or skull. Contact with the earlier populations resulted in wife purchase and the development of secret societies. They introduced the cult of the dead and the institutions of taboo, totemism, and chieftainship, an outrigger canoe, money, the slit drum or gong, the conch trumpet, megalithic monuments, and the fowl, pig, and dog. There may have been two immigrations of peoples who made monuments of stone. (1) Those who erected the more dolmen-like structures, probably had aquatic totems, and interred their dead in the extended position; (2) and later, those whose stone structures tended to take the form of pyramids, who had bird totems, practised a cult of the sun, and cremated their dead.

These immigrants found a people divided into two exogamous groups, with matrilineal descent, and three special forms of marriage (with daughter's daughter, wife of mother's brother, and wife of father's father), they had rectilinear decorative designs, and employed the bullroarer. The dual organisation seems to have been formed by fusion rather than by fission, judging from the frequent survival of hostility between the two moieties, their mythology, character, and possibly even slight traces of differences in physique. Whatever the previous social condition of each moiety, a fusion of two races under certain conditions might produce matrilineal descent. The dual organisation would thus imply a dual origin, of which the immigrant people spoke an Austronesian language (as did the kava and betel peoples), interred their dead in a sitting position, feared the dead, believed in spirits, practised circumcision, introduced the bow and arrow, and an outrigger canoe. The Baining of New Britain may represent, though, of course, in a modified form, the aboriginal elements of the dual people; they are devoid of any fear of the dead, and their small stature suggests that the pre-dual people may have been pygmies.

Dr. Rivers has produced a work which will have far-reaching results, it being not merely a storehouse of facts, but a demonstration of method, and conclusions are arrived at which will be sure to provoke discussion. Whatever may be the final results of such discussions, this book will probably take rank as a landmark in the study of ethnology. A. C. HADDON.

TYPHUS FEVER.

TYPHUS fever, which has just appeared in some of the prisoners' camps in Germany and is rife in Serbia, has been one of the great epidemic diseases of the world. Hirsch remarked:—"The history of typhus is written in those dark pages of the world's story which tell of the grievous visitations of mankind by war, famine, and misery of every kind."

The name is of no great antiquity, for it was applied to a malady or group of maladies first by Sauvages in 1759. Until then, from the time of Hippocrates downwards, it had been employed to designate a confused state of intellect, with a tendency to stupor. It was, in fact, not until 1850 that typhus fever was finally differentiated from typhoid or enteric fever by the researches of Jenner. One of the older synonyms for the disease was *jail fever*, and in the sixteenth century, at the first three of the famous "Black Assizes," judges, sheriffs, and jurymen were stricken with it as the result of infection from prisoners brought for trial. Another name formerly given to it is *Morbus castrensis* or "military fever," on account of the ravages occasioned by it among soldiers and camp followers from the time of the Thirty Years' War and the English Civil War down to the siege of Sebastopol. Owing to the character of the eruption, typhus fever has sometimes been termed "spotted fever" (to be distinguished from cerebro-spinal fever, also known as spotted fever), and the German name is *flecktyphus,* also *typhus exanthematicus,* to distinguish it from *typhus abdominalis*, typhoid or enteric fever. The French name is similarly *typhus exanthématique.* Brill's disease, met with in New York, and Tabadillo of Mexico, seem to be manifestations of it. Few countries have suffered more than Ireland, and the disease has lingered in the outer Hebrides, but of late years has been practically unknown in England, and is seen but rarely in Scotland.

The invasion of typhus is, in the majority of cases, like pneumonia, sudden and severe after an incubation period of about twelve days. On the fourth or fifth day the eruption appears, first measly in character, but appearing on the wrists, trunk, and thighs, and afterwards becoming hæmorrhagic. The patient then suffers from severe fever with its usual concomitants, passing into extreme prostration. The nervous system suffers severely, and there is great muscular restlessness and tremor, excitement and delirium. In favourable cases the attack ends comparatively suddenly about the fourteenth day.

There are, of course, considerable variations in the course of the disease in individual cases; it is always to be regarded as a serious affection, and the average death-rate for all ages under favourable conditions is 15–19 per cent.; no age is exempt. An attack of typhus affords marked protection, and second attacks are as rare as those of small-pox. No special treatment for it has yet been discovered.

The ætiology of the disease is still uncertain: no specific micro-organism has been discovered, but it is probably protozoan in nature.

Typhus is markedly infectious, and the infectivity is greater the larger the number of cases which are aggregated together. The mode of spread for a long time was uncertain, and until recently it was regarded as being conveyed by the emanations from the patient. A few years ago, in the epidemic which occurred in Aberdeen, Prof. Matthew Hay made the pregnant suggestion, on epidemiological grounds, that the disease might be conveyed by fleas. Further investigations have conclusively proved that it is conveyed by the body-louse, possibly by the head-louse also. This important fact explains how it is that typhus is so prone to appear in times of stress, war, and famine—when misery prevails and personal cleanliness is difficult or impossible to maintain.

Prevention of the spread of the disease largely resolves itself, therefore, into extermination of lice, and much attention is now being directed to the means which may attain this end. R. T. H.

AN ADVISORY COUNCIL ON INDUSTRIAL RESEARCH.

THE proposed formation of an Advisory Council concerned with industrial and scientific research was announced by Mr. J. A. Pease, President of the Board of Education, to the deputation of which we gave an account last week. The scheme was described by Mr. Pease in Committee of the House of Commons on May 13 in connection with the Education Estimates; and the debate which followed upon it was one of the most important from a scientific point of view that has been heard in the House for a long time.

The general question of the relation of science to the State, and the particular work which a suitably constituted Advisory Council could undertake, are dealt with elsewhere in this issue of NATURE by Sir William Ramsay. We need scarcely remind our readers that the need for increased provision for research in pure and applied science has been urged in these columns for many years by leaders in the scientific world concerned not only with the advancement of natural knowledge, but also with the promotion of national prosperity. For the past ten years the British Science Guild has been continuously endeavouring, with little encouragement, to secure public and official recognition of scientific research and organisation as essential factors of industrial progress. It has shown over and over again that whereas in Germany the State fosters all work and institutions engaged in scientific work and advanced technology, and in the United States private benefactions increase the endowments for such purposes at the rate of about 5,000,000*l*. annually, in the United Kingdom neither the State nor the generosity of individuals makes provision for research on a scale at a l comparable with what is done in the two countries which are our chief competitors in the industrial world.

The war has brought to the forefront the national necessities to which Sir Norman Lockyer directed attention in his presidential address to the British Association at Southport in 1903, and throughout its existence the British Science Gui'd has persistently endeavoured to stimulate action which would encourage the expansion, and promote the use, of the scientific forces of the Empire. At last both men of science and members of Parliament have awakened to a sense of the importance of these matters; and, as we reported last week, representatives of the Royal Society and the Chemical Society have urged upon the Government the need for intimate interest by the State in scientific research and its relation to manufactures. We congratulate these and other societies upon the support thus given to the efforts of the British Science Guild to organise scientific work in the interests of national welfare.

Political leaders have expressed, from time to time, their sympathetic interest in scientific investigation and their belief in its influence upon industrial development, but until now little attempt has been made to give practical value to their profession. The unanimity with which the scheme put forward by Mr. Pease was supported in the House of Commons shows that all parties are prepared to make adequate provision for scientific work and its organisation in the interests of industry when a definite policy is proposed. We reprint below, from the official report of the debate on May 13 (Parliamentary Debates, vol. lxxi., No. 52) the main parts of speeches referring to the Advisory Council.

Mr. Pease: The war has brought home to us and to our notice that we have been far too dependent for very many processes and many materials upon the foreigner, and we have realised that it is essential, if we are going to maintain our position in the world, to make better use of our scientifically trained workers, that we must increase the number of those workers, and that we must endeavour to secure that industry is closely associated with our scientific workers, and promote a proper system of encouragement of research workers, especially in our universities. The fault in the past, no doubt, has been partly due to the remissness on the part of the Government in failing to create careers for scientific men. It has also, I think, been due partly to the universities, who have not realised how important it is that pure science ought to be utilised with applied science and brought into close contact with manufacturing interests. I think it was also partly due to the fact that the manufacturers themselves under-valued the importance of scie ce in connection with their particular industries. It was partly due, too, to the fact that the ratepayers have been too niggardly in making provision in connection with their technical institutions and colleges.

I ought, perhaps, to give a few illustrations to the House in order to show that by expenditure in the first instance of a comparatively small sum of money, which ought to develop into very substantial sums of money in the future, much can be done by research workers, and by properly scientifically trained individuals in regard to many of those processes for which hitherto we have been dependent upon other countries. We relied upon Germany for hard porcelain tubes used in pyrometers which are required for measuring high temperature. On a supply of these pyrometers depends the manufacture of needles required for the sewing of boots and providing the footgear of our troops. I am glad to say that, owing to the research work that has taken place recently, we are now able to produce as good porcelain as that previously produced for this purpose in Germany, and we are able, therefore, to produce the necessary needles for this purpose. It may astonish the House when I tell them that, whereas four firms in Germany employ 1000 chemists in connection with their dye works, in the whole of our industries there are only 1500 chemists employed. There are in Germany more than 3000 students, even at the present time, so far as I can learn, studying research work in connection with their university life, whilst in this country I do not think we have more than 350 students engaged in such research work. Let me give another illustration of the success which may be secured by research work. Our successes over our enemy in aviation are very largely due to the investigations made into automatic stability by a young man who went through an elementary school, fought his way up to the Imperial College, and went through a course at the National Physical Laboratory, and invented and introduced the B.E. biplane—at any rate, from his investigations the B.E. biplane was developed. We have hitherto done very little to encourage these brilliant young men taking up a scientific career.

The average salary given to a junior teacher of science is, I am told, only about 150*l*. a year. With a meagre salary of that kind it is not to be expected that individuals are going to endeavour to enter a career which is so badly rewarded. Let me give the Committee just one other illustration of what research may do. Lyddite was made at the commencement of the war out of phenol. The price went up at once from 6*d*. to 5*s*., and owing to laboratory experiments conducted by Prof. Green at Leeds he was able to reduce the cost to 1*s*., as lyddite can now be made from benzol. That was entirely attributable to the research work of one man. If those things can successfully be done in times of war, I know how many things can be done in times of peace. I have been associated myself with the production of a large number of by-products from coal, and it was even necessary to go to Germany for the bricks and plant in order to erect a certain oven in this country. I satisfied myself that it is possible that these materials can be produced, and ought to be produced, at home, if only we had a sufficient number of research workers and trained men of science turning to practical value their scientific training.

I could go on and develop this subject. I see opposite a representative from Ireland who asked me a question in regard to technical optics, and there is a great deal of work to be done in this country with reference to that subject. A professor told me the other day that it had only just been found out why they were making so many failures. A greenish hue came into the glass they were producing, and in consequence they were unable to produce the necessary lenses. By research work it was found that this was due to barium oxide being contaminated with iron, and they had to go to another source in order to obtain the glass free from this impurity. And so I might go on and give case after case where by research and a little expenditure on the scientific training of able men we would be able as a country to succeed just in the same way as the Germans have succeeded in recent years. My fear is that after the war we shall have to contend with a fiercer competition than we have had to contend with even in recent years, and it will be conducted by our enemy with less scrupulous methods. The Government agree with me that something ought to be done at once, and we must make more use of the workers in our country and prepare for an increased supply of them, and bring our universities and technical institutions into closer association with industry, and also bring our leaders of industry into closer association with skilled workers. Steps must be taken at once. Adequate supplies require prolonged endeavour. The task immediately before us may be advanced at once by the appointment of an Advisory Council on Industrial Research. I want a Committee of experts who will themselves be able to consult other expert committees working in different directions. They, in turn, must be associated with leaders of industry. We shall want advisers representing various industries in the country who not only possess certain knowledge in connection with pure science, but will be able to turn to the best account the knowledge they have acquired in the application of that knowledge to industry. We shall work in close co-operation with the Board of Trade, who are seconding the efforts of my old board. Such a body as an Advisory Council of very distinguished men upon whom we shall rely for advice, ought to be at work, and I hope it will be at work within the next few weeks. I am now considering the names, although I am not in a position to name them at the moment.

So soon as we get a Committee of that kind nominated they will at once begin their work. The solution of several problems will be placed before them in connection with the glass industry, the making of hard porcelain, technical optics; and it will be one of their duties to secure selected workers who have passed through graduated courses suitable for doing research work in laboratories in the solution of a certain number of definite problems. They will have to advise me as to how money should be immediately spent, and how it should be subsequently spent when we are able to obtain rather larger grants from the Treasury than we shall have at our disposal during the current year. They will have to advise as to the way money should be spent in training and research work generally, and how money should be spent and distributed amongst specialised departments, such as the Imperial College of Science at South Kensington. What I am anxious to secure is the use of the best scientific brains in connection with this enormous problem which is of such vital importance to the country. I hope to place on the Estimates for the current year a sum between 25,000*l.* and 30,000*l.*, but the demand for money for this work will enormously increase as time goes on, and I want to inform the House that whilst we are beginning with this comparatively small sum we think it will develop, and if the scheme is to succeed I believe it must depend upon State help in the years to come, and State help must steadily progress.

As I have been longer in my present post than any of my predecessors, I may be allowed to say that in my judgment two things are essential in the interests of this country if we are to maintain our position and succeed in the future and remain in the proud position, industrially and commercially, in which we are now situated. First, that after the war, and even during the war, an effort should be made to retain longer at school those who are able to benefit by further education. Too many now leave school at the ages of twelve, thirteen, and fourteen, and there is an enormous wastage of ability in the country owing to the non-education of the children after that age. Secondly, the nation should create careers for men who are capable in the scientific world of benefiting that problem. If we had these two things I believe we should maintain our position, and without them I am afraid we shall be discouraged. Therefore, so far as I am able, I wish to appeal to all those men throughout the country who are devoting their lives to the cause of education to do what they can to encourage, not only the longer education of abler children in the secondary schools, but also to make the scheme which I have outlined here this evening very briefly a success in connection with training scientific workers who will be a real advantage to the industries of this country in years to come.

SIR PHILIP MAGNUS: I have no doubt whatever that the scheme for co-ordinating more successfully the science of industry will be welcomed by all scientific men in this country. I should not like it to be thought for one moment that our universities and our technical institutions have failed to turn out a sufficient number of scientifically trained men to be able to carry on research work in connection with our industries almost to the same extent that it has been done in other countries. Where we have to some extent, and to a large extent, failed in this country is in the appreciation of manufacturers and employers of the value and importance of such scientific training, and if the conclusions at which the President has arrived, and if the facts connected with this war will bring home to our manufacturers and employers the great advantage which they can obtain by liberally supporting scientific men in connection with their work, then the Right Hon. gentleman will not have spoken in vain this evening.

There is nothing in which we have been more deficient in this country than in scientific organisation, and, if I may say so, in the organisation of our science, and to this I hope that any such council as he has proposed will diligently apply itself. We have a great number of institutions doing excellent work, but the work of one often overlaps that of another. We want very carefully to see that each institution does that work which it is best fitted to do, and that manufacturers shall have no difficulty whatever in obtaining through any technical or scientific institution the particular class of scientific man which will be helpful in the industry in which they are employed. Take London, for instance. We have already the Imperial College of Science and Technology, on the organisation committee of which I was a member. We have also the Imperial Institute, in which a certain amount of research work is being done of a very high quality in connection with our colleges. We have also, not very far removed, the National Physical Laboratory, where research work is being done, but where more research work might be done if larger funds were available for the purpose. In Berlin there is what is called the Reichsanstalt. That is a research institute which combines the work of our national institute and the National Physical Laboratory, and that institute is placed in close juxtaposition with its Imperial Institute of Science and Technology, which goes by the name of Charlottenburg.

The President of the Board of Education has referred to the fact that it is very difficult to obtain men who will be attracted to the profession of technologists at a salary of 150*l.* a year. I was sorry that he did not remember that the Government itself has advertised for very highly skilled technical chemists at Woolwich at that same salary. I complained of that years ago, but I was told that there was quite a sufficient number of highly skilled chemists only too glad to accept the position at that small sum. I hope that the Government will be the first to take to heart the lesson which the Right Hon. gentleman has given. There is only one other word I want to say at the present time. I heard with great satisfaction that it is proposed in the scheme to which the President referred that the Board of Trade shall be associated with the Board of Education. I attach great importance to that, because we do not want in this work merely theoretical scientific men. We want men who are imbued with the commercial spirit, and it is desirable that in any body who are to direct instruction by giving suggestions you should combine those who have an intimate knowledge of the trade requirements with those who at the same time are developing the scientific instruction itself. Personally, in the thirty-five years during which I have been associated in, it may be, a feeble endeavour to bring science to some extent to bear upon industry, I have always been most careful to see that the commercial requirements of those engaged in the trade are carefully considered by those who have the task of organising the schemes of instruction. I am glad to see that same policy is likely to be carried out by the President of the Board of Education acting in conjunction with the President of the Board of Trade.

SIR JAMES YOXALL: I think that the Right Hon. gentleman even to-night attached more importance to the highly technical education which has been procurable in Germany under the German system of education than was just. The impression I have been able to form after years of study has been that it is probable that during the last twenty or twenty-five years as many capable men of science, highly skilled chemists and physicists, have been produced by the educational system of this country as has been produced in Germany. My impression is that probably in number, and certainly in quality, even our somewhat unorganised and uncoordinated British system has produced quite sufficient men to provide the industries of this country with sufficient guides, leaders, and captains. The fault has been not with them, or with the schools, colleges, and universities, but, no doubt, with the manufacturers and employers of this country, who have been blind to the opportunities which this material has presented to their hands. Even now, when my Right Hon. friend has created his excellent Advisory Committee, and has used his new grant and has developed further this admirable attempt on the part of the Government to provide for what may happen with regard to industry after the war, little will be the result so long as it is rooted in the minds of employers and capitalists that rule of thumb is better than rule of brain. I would suggest to my Right Hon. friend that he might consider, as a development of what he has submitted to-night, the running of this great concern which he has in view on a commercial basis, so that if manufacturers and capitalists will not take up this work, the State itself should take it up, and provide and sell to the manufacturers the results of researches which otherwise they would not obtain.

MR. ANDERSON: Perhaps the most important matter raised by the President to-night was that of establishing an Advisory Council to deal with matters relating to science and industry, and to bring science into closer touch with industry. That is a very important statement. Personally, I believe that it is along these progressive lines, and not by adopting reactionary policies, that the nation is going to hold its own in regard to industry and trade. We have not in the past spent anything like the amount of money we should have spent in regard to scientific research and technical training. We ought to equip ourselves to the fullest extent along these lines, and it is by doing so rather than by adopting backward policies that we are going to make headway in the future. You ought to try to bring science and industry into closer touch with each other and to make science the great servant of industry, to make it a more practical matter rather than merely be taken up with abstract questions, and you ought to avail yourselves to the fullest extent of the practical knowledge and experience of the working people who are now employed in the factories, in the mills, in the workshops, and so on, and I believe in regard to that, that your Advisory Committee ought to have representatives of labour so as to show that you are going to bring the practical knowledge and experience of the workpeople into account in this matter, and I believe it will be important from the point of view of the success and welfare of your scheme.

MR. LYNCH: Whatever we think of the material aspects of Germany, we really have in her history one of the most extraordinary examples in the whole history of the world of a nation gradually rising to great material power on a foundation of high scientific education. The rise of Germany does not date, as some have said, merely from the great victories in 1870, but from a much earlier epoch when a German with a less salary than the then President of the Board of Education held that office for only two years, and yet within those two years left such a stamp on the education of Germany that it has remained ever since, and has been the real source of the education of the nation—Wilhelm von Humboldt.

Let us consider now one of the questions referred to by the President of the Board of Education to-night, technical education. When we speak of technical education in this country we are too apt to think of trifling details, such as wood carving and filigree work, or such as crewel-work or crocheting impossible parrots on the background of some fancy cloth. In Germany technical education has a very different and a much higher meaning, and having had the advantage of studying in the University of Berlin myself, I can say that one of the most abiding impressions of my whole life was the extraordinary revelation I had there, not merely of the devotion to science itself, but of the manner in which that widened out the whole horizon and prospect of the nation's view, and the way in which science was seen to be the vital influence in great enterprises and wonderful industries. I would not labour this question to-night, but those who have leisure might refer to an article by Sir William Ramsay, first published in NATURE in November, 1914, but to which my attention was called in the French paper *La Revue Scientifique*. The French recognise the value of that article, and in France I think it got wider publicity than in this country. Sir William Ramsay analyses the causes of the greatness of Germany in the industrial world, and he finds several very interesting points which he tabulates. The first is that in a great German industry the board of directors are not a set of ornamental magnates with a peer thrown in to give respectability or publicity, but are a board of specialists on that subject which is the basis of the industry, keen and hard-working men. Secondly, that there is another agency definitely appointed with the definite active functions to watch out for new inventions in other countries. I could enter into this question very deeply, and I could show that right throughout the range of industry there are cases where the real central idea of that industry has not originated in Germany, but in France, England, or America. I believe if I were to ask which is the nation most fertile in ideas and most inventive, from my own brief experience I would be inclined to place the French in inventive genius above even the Americans. The Germans are always looking out and asking the question, "In what way can we utilise new inventions for the benefit of our own industry?" That forms No. 2 of the points of Sir William Ramsay.

The third is that there is another agency always asking the question as to the cheaper production of the material, not in a passive way, but in an active way; in making inquiries and making voyages to other countries, examining what is done there and exploiting the brains of other men, often covering up the source. That is what the Germans call war. Then comes in the question of protection by the Government. There is a point where the Government could actively intervene to foster industry. Another point not less important is the protection of patents. In many cases Germans have gone so far as to steal the patent from other countries and protect themselves by patents from the other country recovering its ideas. Then there is the propaganda of the excellence of their own products, sending men throughout the world, speaking many languages, active missionaries of the active progress and greatness of Germany. I will cite several industries. The German spirit of organisation is so great that in the most unexpected fields it is exhibited. I remember one of the most prominent mathematicians, M. Picard, of the Institute, who said that though perhaps there had been great names in the history of French mathematics equal to those of the Germans, such as M. Poincaré, who I am proud to have called my friend, who recently died; yet the Germans had pushed their organisation so far that even in that field, so abstruse, they had perfected an organisation for that study.

Take the question of aniline dyes, of which we have heard so much, and which has been the subject of consideration in this House. It is always said in this House, and in the public prints and text-books, that the story of aniline dyes is that a British chemist, Dr. Perkin, discovered and invented a new dye, and that was stolen by the Germans. The matter does not rest in such a passive way at all. Perkin was not, I believe, the first man to produce coloured material from the by-products of coal tar. That was done by Runge some years before. In 1856 Perkin produced his first aniline dye, mauve, and that was considered a great achievement in this country. Already the Germans were beginning that extraordinary organisation of which they are the masters. They seized hold of this, saw its possibilities, and set to work in all the laboratories of that great kingdom, particularly Prussia, and soon produced a whole succession of aniline dyes. They opened up new possibilities, and in this way founded their industry in a perfectly legitimate manner. So that the lack in this country was first a want of appreciation of the value of that discovery, and then the want of active organisation to make use of the discovery when found.

Or take, again, the case of glass, also raised by the President of the Board of Education. The manufacture of glass, of course, has gone on from time immemorial. As a matter of fact, one of the oldest glass manufactories in the world was in what at that time was a Roman colony, Cologne. The most interesting development of the glass industry, however, was, perhaps, the manufacture of optical glass. It arose in this way: A German physicist of great ability, Abbe, noticed that a great deal of the finest microscopical work was robbed of its value by the difficulty of obtaining good optical glass, and so he turned directly away from his own study, sacrificed himself in a certain measure—that is to say, sacrificed his scientific ambitions—upon the altar of the industry of the Fatherland, and devoted his great talents to the study of glass in itself. Being a man of scientific endowment, he speedily discovered what those who had been engaged in the industry before without scientific knowledge might not have discovered in a hundred years in reference to the manufacture of glass. Then came another point which has been raised earlier in the debate. After having reached a certain point, he found that it would be difficult for him to proceed without being sustained financially. He then appealed to the State. The German State was intelligent enough to foster his researches in every possible way, to pay him not merely for his chemical research, but for his endeavour to build up a great industry. So there you have a striking example of the alliance of science with industry, and of State aid supporting both, one which we might very well take to heart. The result was the building up of an industry which imposed itself upon the whole world, and is one of the legitimate glories of Germany to-day. Every medical student who wishes to do his work well is forced to buy a German microscope.

Compare that with the condition of things in this country. I have come down to this House myself in those days when I was more hopeful and I had a real respect for the Government, and I have pleaded for 10,000*l*. for great research work, research work which would have enabled one of the very few men in this country who stand out in the eyes of the whole world as a great figure in modern science, to do most useful work, and I was received with a certain polite indifference and shunted off. I say that, so far from asking 10,000*l*. for research work, I should have been entitled to ask for 10,000,000*l*.—that is to say, if I could ask with sufficient authority—to stimulate in every possible direction the great industries of this country. I go so far as to say that eventually the whole civilisation of this world, and not merely of England itself, must turn on the axis of science, and as we advance we must give proportionately greater and greater importance to this great development of scientific life. When I was a student some years ago of some of these questions, of which I have only given one or two examples out of hundreds which I could expound to the House, I made this extraordinary discovery, that in tracing out the development of science I was really in my own mind proceeding with the development of Humboldt's cosmos. That is to say, that science is the roof of civilisation, and our civilisation is superior to that of the Greeks only in one particular, and that one particular is the advance in positive science. As a result of the advance of positive science our modern civilisation has reached that great expansion which we now recognise.

Then the President spoke about the number of chemists in this country, and said that the number of research students in chemistry is only 350, and yet this country is competing in the commercial world with Germany! I have looked into the organisation in Germany, and I find this astonishing fact: That, in the great chemical works in Germany, for every fifteen men employed in any category whatever there is one highly trained specialist and chemist, and that this industry is so important that there is one highly trained specialist in chemistry for every forty-five employés in any category, right throughout the whole range of industry. When we reach facts like these, are we astonished at the pacific invasion of Germany in every country in the world which, had they been sage enough, would in fifty years have given them a mastery of the world without the cruel and brutal and abominable war which has caused such suffering? But knowing the enormous disparity between one trained chemist for every forty-five employés in all industries, and a total of 350 research students in this country, how are these defects to be remedied? Partly by giving encouragement to students of science. That is important, but it is not all. I asked a question in this House about the pay of students of chemistry. I find that the War Office itself, which is advertising for students of chemistry, some of them men with degrees, all of them required to do analytical work of a really very difficult kind, such as, after a man obtains his degree in chemistry, would require some special training for at least six months to do the work with the requisite degree of fineness, offered to these men a salary of—1000*l.*? There would be nothing preposterous in that. Some of these men are quite qualified to become professors in the great capitals in the Dominions. Was it 500*l.*? It was 100*l.* With what conditions attached? Those men technically were placed on the same footing as ordinary workmen, and they could have been required, had the regulation been enforced, to join in a queue every Saturday to take their 2*l.* at the pay office.

To-day an advance has been notified by the Under-Secretary for War. They are paid 150*l.* Even that is scarcely enough to stimulate men to follow in the path of scientific research. I do not believe that any man who has the true scientific spirit—I appeal to my hon. friend to back me up there—is ever attracted by the mere sake of gain. There is something of the scientific spirit which is almost incompatible with making money. When I read the lives of the great workers of the past I feel indignation even now. Take, for instance, the record of Faraday. The great man, who stands out among the few whose names will be remembered for a thousand years, even after the records of our own Parliament have passed away, as one of the great pioneers of human civilisation; toiled all his life at the stipend of the valet of a peer, and that, remember, in a country where a man's social status and his work, as he calls it, is judged very largely from the amount of salary that he earns.

There will be a revolution when the war is over; a peaceful revolution, if you will, which will be felt right throughout the world, enlarging our education particularly in regard to our technical schools. We do not want the history of the world in text-books given to children at their most susceptible age, which divide history into reigns of kings and queens, most of them utterly worthless, as if the whole philosophy of the world turned on the sanguinary and wretched and often unintelligible accounts of wars and battles. I hope the time will come when we shall have a clearer and saner view of the whole scope and importance of education. It will be more important for the child to know the date at which Oersted discovered the reaction between electricity and magnetism than even to know the date of the battle of Waterloo. There is in science a real spiritual influence—that it to say, the most alluring and fascinating of all the problems which can attract the mind in the gradual unfolding of the meaning of this world itself in which we live. I would like the President of the Board of Education to take his courage in his hands as did Wilhelm von Humboldt in other days; and if he feels himself not strong enough to do this work solus, let him call in the aid of those enthusiastic in the development of science, and the help of those committees of which he has spoken, to carry out their recommendations, not in the half-hearted way in which matters have sometimes been presented in this House, but with something like the missionary zeal of a new evangel. I am certain that when this war is over if the education of this country remains in the condition in which it now is, you may bolster up your military power, you may build *Dreadnought* after *Dreadnought,* but this country will sink. But if this country is to save itself, to regenerate itself, and to proceed on a new path of high development, then the most vital of all problems is that of education.

MR. KING: On this Vote we have had a chorus of approval in favour of greatly increased expenditure on scientific education. I wish to join in that chorus. You cannot have a nation able to benefit by the scientific research and technical instruction and the various facilities for scientific advance which have been foreshadowed to-night unless you have a good foundation in elementary education. If you begin on the same night to cut and curtail elementary education, you are doing an evil turn to advanced research in scientific education. I wish very heartily to congratulate the representatives of the Board of Education upon having shown what is to my mind the first evidence we have had that statesmanlike foresight exists on the Treasury Bench at the present time. We have had plenty of energetic pushing on of the war, but in grasping the issues of what are to come after, and to prepare for the inevitable changes and difficulties and problems which will immediately arise at the end of the war, this is the first inkling we have had that those considerations are present to the mind of the Government. I congratulate the President of the Board of Education and the Parliamentary Secretary to the Board of Education on the scheme they have put forward. I from time to time directed attention, by means of questions and in other ways, to our great deficiency in scientific and technical education, especially with regard to research. Anybody who knows anything about Germany knows the enormous amount of money and the great numbers of men of the highest ability and training and standing engaged in purely scientific research and inquiry.

Everybody who thinks of it and who studies the question must know that Germany's position in the world to-day is due not to the real genius of the people so much as to organisation combined with education, and especially scientific education. I am very pleased that at this time there is an opportunity for an educational advance. I congratulate the members on the Treasury Bench upon their courage and persistence, for I believe it must have needed something of that kind to get this scheme through the Cabinet. I congratulate them on the prospect of having an early Supplementary Estimate. It is true it is only 25,000*l.* I think it ought to be ten times as much, but I have no doubt it is an estimate that will grow. I should like to recall to the members of the Committee the historical references, to my mind of great significance, which we had from the hon. member for West Clare (Mr. Lynch). It was in the year 1809, only two years after the Peace of Tilsit, that Prussia started the University of Berlin. Prussia had been robbed of half its territory by the Peace of Tilsit, which also imposed upon it an enormous indemnity. It had also to support a huge French army of occupation until the indemnity was paid. Yet in that very time Stein and Wilhelm von Humboldt founded the University of Berlin, which has become for its equipment and influence in scientific matters by far the greatest University in the world. They also established at the same time, when the taxes were simply overwhelmingly crushing, the elementary-school system of Prussia, which remains to the present day. I say that a nation that could so appreciate in its hour of ruin the value of education is a lesson to us which we ought to take to heart.

MR. RAWLINSON: I was very glad to hear the President's announcement of the creation of an Advisory Council to deal with this matter, and I need scarcely say that though I have not been able to consult them upon the point, the University of Cambridge, I am sure, will give most unstinted support to the scheme, such as it is. Whether it will be a success or not will depend upon matters which we cannot discuss to-night. It will depend largely upon the men and upon the methods by which the work is carried out. No one doubts that there is a need for it at the present time. The Right Hon. gentleman has enumerated some of the things in connection with which we have discovered the need, and he could have made a much longer list—things which are vitally important for the carrying on of the war. This country has had brought home to it the recklessness of any island country being dependent for its supplies to a large extent upon places outside its bounds. That is one of the lessons we shall learn from the war. It must be remembered that scientific men have been connected with agriculture and industry in this country before. They were connected with it in the best possible way; they were present while the work was being done. But in one case after the other the Germans bought up those firms and practically carried the industries away to Germany. We must not have that occur again. It is not merely a question of scientific research; it is much more a question of policy. So far as the scientific side is concerned, I think that even the President of the Board of Education was scarcely sufficiently optimistic when speaking of the enormous supply of men in the universities who are perfectly qualified and ready to take part in the industrial side of science. A large number are already doing so, and a very much larger number are perfectly ready and willing to take part and assist in the science of industries of any kind.

DR. ADDISON: There are many things which we must attend to without any delay, and it is for this reason that the Committee for Research will be set up quite soon. A great deal has been done by private effort in respect of research, and notwithstanding all that my hon. friend the Member for West Clare (Mr. Lynch) has pointed out, quite properly, in this connection, I think that the research which has been associated with British men of science has often been the most original of any in the whole world. We have not organised and developed it as we ought to have, but the British researcher is often freer in his outlook and greater in his conceptions, I think, than almost any other. At all events, he certainly stands far above the average German researcher, who tends more to apply the ideas which have been suggested by others, but from all that my hon. friend pointed out we have got to recognise that we cannot afford nowadays to leave all this to private effort. A great deal can be done by careful organisation and by seeing that the men turned out from our universities and technological institutions are equipped with that training which will make them acceptable in industry, and make them more likely to find a good market and a good career for themselves. Going around our institutions you will find certain departments where the professors will tell you that they cannot supply the men quickly enough to the manufacturers, while in other departments it is quite the reverse. The Royal Society has lately, very patriotically, been assisting chemical research in respect of drugs. This was one of the matters in which we felt ourselves behindhand at the beginning of the war. However, I think that my Right Hon. friend may be satisfied with the full assent of the House in all quarters in getting ahead with this great scheme, which, while we hear so much of the mobilisation of our industries with respect to the production of munitions of war, will quickly, for the first time in this country, show that we are going to some extent, at all events, to create a machine which will enable us to mobilise brains and science in the service of industry and national progress.

NOTES.

THE annual visitation of the Royal Observatory at Greenwich will be held on Saturday, June 5.

SIR WILLIAM CROOKES and Prof. R. Meldola have been elected honorary members of the Society of Public Analysts.

WE learn with regret of the death, on May 8, of Dr. P. Zeeman, since 1902 professor of geometry and theoretical mechanics in the University of Leyden.

PROFS. MAURICE CAULLERY (Paris), Charles Henri Marie Flahault (Montpellier), and Jacques Loeb (Chicago) have been elected foreign members of the Linnean Society.

THE London County Council has decided to commemorate the residence of Lord Lister in London by placing a memorial tablet on the house, 12 Park Crescent, Marylebone Road.

WE regret to announce the death on May 13, in his eighty-ninth year, of Dr. M. W. Crofton, F.R.S., formerly professor of mathematics at Queen's College, Galway, and also, later, professor of mathematics and mechanics at the Royal Military Academy, Woolwich.

SIR DAVID BRUCE will this year deliver the Croonian lectures at the Royal College of Physicians of London on June 17, 22, 24, and 29. His subject will be "Trypanosomes causing Disease in Man and Domestic Animals in Central Africa."

AT the annual meeting of the Iron and Steel Institute last week, the Bessemer gold medal of the institute for 1915 was, in the unavoidable absence of the French Ambassador, handed to M. de Fleuriau, councillor of the French Embassy, for transmission to M. Pierre Martin, for his invention of the open-hearth system of steel manufacture.

THE regents of the American College of Surgeons announce the appointment of Dr. J. G. Bowman as director of the college. The college was founded in 1913, and is an organisation of the surgeons of the United States and of Canada, having for its purpose the advancement of the art and science of surgery. The address of the executive offices is 30 North Michigan Avenue, Chicago.

THE trustees of Columbia University, in the city of New York, have awarded the Barnard gold medal to Prof. W. H. Bragg, Cavendish professor of physics in the University of Leeds, and his son, Mr. W. L. Bragg, fellow of Trinity College, Cambridge, and a member of the college staff, at present holding a commission in the Leicestershire R.H.A. (T.F.), for their work on X-rays and crystals. The medal is awarded every five years for "meritorious service to science," on the recommendation of the National Academy of Sciences of the United States. The previous recipients have been Lord Rayleigh and Sir William Ramsay, Prof. von Röntgen, Prof. Henri Becquerel, and Sir Ernest Rutherford.

A PARTIALLY restored skeleton of a small ancestral camel, *Stenomylus hitchcocki,* from the Lower Miocene of Nebraska, U.S.A., has just been added to the exhibited collection in the geological department of the British Museum (Natural History). The specimen was obtained from Prof. F. B. Loomis, of Amherst College, Mass., who discovered the remains of a herd of these small animals which had been suddenly destroyed and buried by some local accident. As a camel, Stenomylus is remarkable for its extremely slender build, which would render it as agile as a gazelle. It also has molar teeth with unusually deep crowns, so that it would be able to feed on hard and dry grasses. It was therefore more completely adapted for life on open plains and uplands than the other camels which abounded in North America in Oligocene and Miocene times.

THE death is announced in *Science* of Mr. E. W. Morse, formerly instructor in natural history at the Bussey Institution of Harvard University, whose name is associated with his contributions to the history of domesticated animals. Mr. Morse more recently acted as a specialist in animal husbandry in the U.S. Department of Agriculture. In addition to his official duties as an associate editor of the *Experiment Station Record*, and later as an expert in the U.S. Dairy Division, Mr. Morse was instrumental in putting the foundations of animal breeding and feeding on firmer bases. He was an active member of the Biological Society of Washington, the American Society of Animal Nutrition, and the Boston Society of Natural History, and a regular contributor to several standard year-books and encyclopædias.

THE issue of *Science* for May 7 announces the completion of the rebuilding of the Gray Herbarium in connection with Harvard University. The work of enlargement and rebuilding was begun in 1909, and has been carried out a section at a time as the generosity of many benefactors made extension possible. The herbarium dates from 1864, when the late Mr. Nathaniel Thayer gave a building to house the botanical collections which Asa Gray had presented to the University. The primary ideals followed in rebuilding have been those of safety, permanence, and convenience of arrangement, but the elevation of the new structure gives the impression of dignified simplicity and great solidity. During the whole period of reconstruction the herbarium and its library have been open as usual for consultation.

ENGINEERS in many parts of the world will notice with regret that the name of Dr. Fred Stark Pearson appears in the list of those lost in the *Lusitania*. We are indebted to the *Engineer* for May 14 for the following particulars of Dr. Pearson's career. He was widely known on account of the construction of many notable reservoirs for water supply in sub-tropical countries, his first great work of the kind being undertaken in the Republic of Mexico. He became a director of the Puebla Tramway, Light and Power Company, owning five different properties in the Republic of Mexico, and from his long and intimate association with these enterprises he became acquainted with other industrial openings in Latin-America. Gradually he took up interests in concessions, and lent his great talents to the development of many similar enterprises in Mexico, Argentina, Brazil, Paraguay, and Texas. Perhaps Dr. Pearson's most notable enterprise was in connection with the design for, and the construction of, the great hydro-electric station at Necaxa, Mexico, and the construction of a transmission line to a distributing station erected at the city of Mexico, situated some ninety-five miles distant. The success achieved by Dr. Pearson in connection with these Mexican enterprises led to his association with similar projects in different parts of the world, and to his becoming what he at first never intended to be—a company promoter and professional director. In addition to his membership of the American institutions, he was a member of the Institution of Civil Engineers.

By the death of Lieutenant Thomas Wright, who was killed while reconnoitring at night on Sunday, May 2, the staff of the faculty of science at King's College, London, has lost one of its most promising younger men. Mr. Wright studied chemistry under Prof. J. M. Thomson and Prof. Herbert Jackson from 1908 to 1912, completing his course with the associateship of the Institute of Chemistry and first-class honours at the B.Sc. examination. Soon after graduation he was appointed demonstrator in chemistry, and during his short tenure of this post he displayed the greatest energy in teaching science students of all faculties and many races. He came of yeoman stock, and his practical and intimate knowledge of agriculture added to the value of his chemical studies, and although he was not spared to complete any original research, he had already given proofs of an ability, power of observation, and keen insight which would have been of great value at the present time, when the nation so sorely needs numbers of such young men of science. In 1914 Mr. Wright gained an Anglo-German scholarship on the Cassel Foundation, the only one awarded outside Oxford or Cambridge. He was to have proceeded to Germany for further study and research, but the outbreak of war found him under arms as a trooper in King Edward's Horse. He received a commission in the Berkshire Regiment in December, 1914, and was sent out to France in the early spring. As an officer he displayed the same ability, zeal, and initiative which had characterised his all too brief career at King's College. His death means a serious actual loss to his college and potentially to science also, while all who knew him mourn that such a promising life should have passed into silence.

IN *Man* for May, Mr. K. A. C. Cresswell supplements from another field the very interesting paper by Prof. J. L. Myres on the causes of rise and fall in the population of the ancient world (*Eugenics Review*, vol. vii., p. 15), which was practically confined to one field, the Mediterranean. He now extends the survey to Mesopotamia, Persia, and Central Asia. He dwells on the importance of irrigation in the agriculture of these regions, and on the fact that there is historical evidence to show that ages of warfare caused the decay of the canal and karez systems of water supply. He is therefore led to the conclusion that the chief cause of the great fluctuations of the population in these regions has been the collapse of the irrigation system, and that but for this neither war nor misgovernment would have sufficed to bring it about, although Ellsworth Huntington has shown that general desiccation has been a factor. Increase of conserved rainfall follows extension of irrigation, and it is suggested that, the chlorophyll reaction being endothermic, there must be a perceptible lowering of the temperature over large tracts of cultivation. If this is the case, it may possibly have an appreciable effect on condensation.

MESSRS. C. G. SELIGMANN and F. G. Parsons describe, in the Journal of the Royal Anthropological Institute for July–December, 1914, a skeleton found in 1903 at Gough's Cave, Cheddar. It is that of a young adult male whose stature was about 5 ft. 4½ in. It was found in association with implements of the late Palæolithic or Magdalenian period. The cranium shows a fairly close resemblance to that of the River Bed type from whom, in the present state of knowledge, the writers believe the Neolithic people to be descended. There are marked contrasts between the Cheddar skull and two of the Aurignacian age with which the writers are familiar, and though the face and the cranium, except that the latter is long, differ rather markedly from those of the Saxons, the cranium alone could not be distinguished from that of a medieval Englishman. The face and orbits are, however, very different. The conclusion arrived at is that the similarity of the Cheddar and English medieval skulls is not so much a sign of racial affinity, as an indication that among the latter a cranium closely resembling that of the River Bed type had been produced incidentally by numerous crosses.

THE Royal Zoological Society of Dublin is to be congratulated, inasmuch as it possesses the only living gorilla in Europe. But, according to the *Irish Naturalist* for May, their captive has been suffering from a tumour on the right side of the neck and face. A microscopic examination of the pus obtained therefrom showed that the growth was due to actinomycosis. This much having been discovered, it became possible to determine on a suitable course of treatment, which we are glad to note gives promise of success. Having regard to the rarity of gorillas in captivity, and the importance of the results of a study of their habits, it is devoutly to be hoped that a complete cure will be effected.

EXPERIMENTS in acclimatisation should never be undertaken save when they promise to yield some definite and worthy end. But what appears to be a quite harmless venture has been made on Lambay Island, Co. Dublin, where, according to the *Irish Naturalist* for May, more than two thousand reptiles and amphibians have been turned out. For economic reasons Dr. Scharff, the director of the Dublin Museum, now suggests an addition to this number in the diamond-backed terrapin (*Malacoclemmys terrapin*). This species he considers might do well in the harbour, since it lives in North America in salt marshes, feeding on molluscs and crabs. In this event a lucrative "fishery" might in course of time be established, since in America terrapin stew—and champagne sauce—is held in high regard.

Two very interesting articles bearing on the problems of sexual selection will be found in the May number of *Wild Life*. The first, which is all too short, is by Mr. H. B. Macpherson, who describes the "tournament" of the blackcock, illustrating his remarks by some admirable photographs. The second is from the pen of Mr. Edmund Selous, and describes the early breeding habits of the shag. Anything Mr. Selous writes about the courtship of birds is sure to be interesting, and this account of the shag is no exception to the rule. His notes seem to show that, as with the Phalaropes, and some other species, the sexual *rôle* is reversed in the matter of courtship, the advances being made by the female. This being so, the assurance that polyandry prevails with this species is not surprising, though the evidence produced to favour this view is by no means convincing.

THE characteristics of molybdenite are discussed in a short but interesting article in the *Scientific Australian* for March. Since the outbreak of the war the price of this mineral has advanced from 60*l*. to 725*l*. per ton. Happily for us, more than half of the molybdenite ore of the world is obtained in Australia. Though principally used for hardening steel—armour plate containing about 20 per cent. of molybdenite—it is also used for the preservation of certain explosives and as a substitute for tungsten, while the salts of molybdenum furnish a blue pigment used in colouring porcelain and in the dyeing of silk and woollen goods. The normal method of washing the ore proving very wasteful, the experiment of oil flotation is being tried, and promises to effect a great saving. Experiments by the United States Bureau of Mines in smelting molybdenite ores electrically are also being made, and these have shown that ferro-molybdenum, low in carbon, can be made directly from molybdenite in the electric furnace, with excess of lime as a desulphurising agent, and that the sulphur can be readily slagged off as calcium sulphide.

THE appalling rate at which the extermination of the native fauna of Australia is proceeding is tersely told by Mr. W. H. Le Souef in the *Scientific Australian* for March. The ravages of foxes and feral cats, introduced by settlers, is answerable for much of the mischief that has been done. The fox, he remarks, "will in course of time overrun the whole of Australia—it is half over already—and in consequence all ground game . . . will suffer severely." The loss to Australia cannot well be computed in cash, as, besides native game, the fox destroys young lambs, turkeys, geese, ducks, and other domestic poultry. The introduction of the rabbit has proved no less disastrous. The realisation that these agents of destruction need never have been introduced makes the consequences the more deplorable. The inevitable removal of timber and scrub, the drainage of swamps, and the erection of miles of wire fences have proved even more speedy and complete factors of elimination. Wire fences alone have accounted for the deaths of thousands of emus and kangaroos, which are now prevented from making their customary migrations in search of water, and consequently die maddened with thirst. Mr. Le Souef pleads for an increase in the number of sanctuaries, and we trust his appeal will not fall on deaf ears.

THE British Museum of Natural History and the Zoological Society are both setting a good example in their endeavour to arouse in the public a more lively sense than hitherto of the dangers which beset us, and especially this year, from the flies which invade and infect our food and drink. In the central hall of the Natural History Museum Dr. W. G. Ridewood has displayed a small case containing most realistic models of various kinds of food and drink and kitchen refuse, all of which are being partaken of by hosts of flies. Clearly-worded labels and diagrams enable the visitor to assimilate at a glance the nature of these scourges and the best way to combat them. Prof. H. Maxwell-Lefroy, at the Zoological Gardens, has entered much more fully into the matter, having prepared an exhibition of living flies and their larvæ, supplemented by specimens preserved in spirit, with samples of various kinds of kitchen refuse which serve as a nidus for these pests. Wall diagrams and lantern slides arranged as transparencies, showing the different kinds of flies and the essential details of their anatomy, add materially to the usefulness of this part of the exhibition. Having thus demonstrated the magnitude of this menace to the community, he proceeds to point out various preventive measures by means of fly-traps, poisons, and fumigatories. Specimens of each are ranged around the room, and all have the merit of being at once cheap and easily and safely used by the careful housewife.

THE Journal of the Royal Society of Arts for April 23 contains a paper by Mr. Moreton Frewen on the State and the fisherman. After dealing with instances of successful fish culture by the United States Fish Commission, Mr. Frewen proceeds to consider the marine fisheries of British Columbia. These are very prolific. There are extensive feeding and spawning grounds for herring, cod, halibut, and many other food fishes, while salmon are very abundant in the great rivers. During the last year or so fairly large quantities of North Pacific halibut have been exported to this country. Dealing more particularly with the Charlotte Islands, the author contends that there is, in that area, a magnificent opportunity for fisheries development on a large scale. Railway and harbour developments in recent years seem to solve the problem of profitable distribution of the fish reared, caught, or canned. A large part of the paper is devoted to the consideration of the establishment of fisher-colonies in Britisn Columbia, formed from partially disabled ex-soldiers and ex-sailors, and from those more adventurous men who will return to civil life on the conclusion of the war. Everything, he contends, points to the great commercial development of this part of our overseas dominions, provided that the State may foster, by scientific investigation and well-planned emigration proposals, its great natural resources.

THE water relationship between the soil and the plant has been the subject of numerous investigations, and it has received further attention from Pulling and Livingstone in a publication recently issued from the Carnegie Institution of Washington (No. 204). One of the authors had previously insisted that the power of the soil to deliver water to root surfaces is the prime external condition determining the moisture supply to plants in normal soils. An osmometer was therefore constructed to obtain information on the phenomena involved, and measurements were taken showing the rate at which water passed from the soil into the cell. For this purpose the large end of the thistle funnel was closed with a collodion membrane obtained by evaporation of a solution of Schering's "celloidin" in a mixture of equal parts of alcohol and ether. This membrane, when properly made, was found to be practically impermeable to dissolved substances, although it readily allowed the passage of water. A cane-sugar solution was introduced, and the instrument was buried in the soil with proper precautions to ensure continuous contact. The rate at which water entered was assumed to indicate the power of the soil to deliver water to the root. It is admitted that the phenomena are complex, but the authors urge that in the present stage more good will result from a direct study of the property as such than from any attempt to analyse it into its component factors. Temperature was found to be of great importance in determining the water-supplying power. A critical point was also found which is said to be approximately the same as that observed by other investigators.

ITALY has taken in hand the study of its own glaciers, and its Società per il Progresso delle Scienze publishes the first number of a *Bolletino del Comitato glaciologico italiano* (Rome, 1914, pp. 1–114, with illustrations). This, after a prefatory statement, gives a bibliography of Italian glaciology from 1895 to 1913, and some reports on investigations in 1913. Prof. A. Roccati describes some glaciers in the Maritime Alps, the largest of which begins at 9219 ft. and ends at 8662 ft. This, like other Alpine regions where the summits rarely attain to 10,000 ft., should afford good illustrations of upland valleys from which glaciers have not long disappeared. Prof. F. Porro furnishes a preliminary report on the Italian Miage Glacier, which has long been noted for the size ot its moraines and its marked advances and retreats. Prof. D. Sangiorgi describes the glaciers eleven of them considerable, from the Disgrazia to the Monte di Zocca. An easily recognised granite occurs in this mountain group, boulders from which are found even to the south of Como. In the Monte Rosa group Dr. Monterin deals with the Lys Glacier and that of the Val d'Ayas, of which the former, like the Gorner Glacier, is still retreating; and the *Bolletino* ends with studies of two glaciers on the Weisshorn or Corno Bianco (10,893 ft.), a peak on the ridge separating the above-named valleys. Altogether a very promising first number, but we hope that the Comitato will keep in touch with the *Zeitschrift für Gletscherkunde*, for a multiplication of separate periodicals is apt to increase rather than diminish the difficulties of those interested in the history of glaciation.

The Società per il Progresso delle Scienze publishes in two small parts a summary (Spedizione Asiatica) of the remarkable work done by Dr. Filippo de Filippi in the Karakoram-Himalayas, but as this is even briefer than the accounts which have been already given in the *Geographical Journal*, we may await the volume, which will in due course appear, to supplement the one which described the exploring journeys in which he took part under the leadership of the Duke of the Abruzzi. Evidently Dr. de Filippi with his well-equipped expedition has succeeded, during an expedition lasting about sixteen months, in adding greatly to our knowledge of the physiography and petrology of a region in which Mont Blanc would be an inconsiderable peak.

In interferometers it has been found convenient to introduce into the path of one of the two interfering beams a plate of plane parallel glass of which the angle of inclination to the beam traversing it could be varied. By this means the optical length of the path could be increased by increasing the inclination of the plate to the path traversed. According to a note by Mr. L. H. Adams, of the U.S. Geophysics Laboratory, published in the Journal of the Washington Academy of Sciences for April 19, a complete theory of the action of such a plate has not previously been available, and he supplies it. A number of important deductions may be made from the theory, one of which is the small effect of the index of refraction of the glass on the sensitiveness of the plate as a compensator.

A recent paper by Mr. W. Calder on oil-well engineering, read before the Institution of Petroleum Technologists on April 30, is well worthy of the attention of all interested in this highly specialised branch of engineering, and perhaps especially of young men who may be intending to devote themselves to this particular department. In this country, where no practical experience in oil-well technology can be obtained, there is perhaps too great a tendency to regard the subject almost exclusively from the geological viewpoint, and this paper comes opportunely to lay emphasis upon the engineering aspect of the work. It makes it very clear that, although for the location of the borehole the services of the geologist are indispensable, yet all the subsequent work depends for its success upon the engineering abilities of the man in charge. Well-drilling is purely a matter of mechanical engineering, and requires for its successful execution not only a thorough mechanical training, but an amount of resourcefulness and ingenuity that can never be acquired unless by men in whom the engineering instinct is innate. Mr. Calder's paper brings the whole subject well up to date, and describes a number of the most modern drilling devices, which, though quite familiar to oil-well engineers, are by no means adequately dealt with in the general literature of the subject; it is therefore an exceedingly useful contribution to oil-well technology.

The twin sciences of heating and ventilation have received little attention in their scientific aspects. In a paper read before the Society of Engineers on May 11, Mr. A. H. Barker dealt with a few of the difficulties of these subjects. He pointed out that physiologists are not even agreed upon what was a healthy temperature for human beings to live in. The heating and ventilating engineer aims at producing comfort, but is baffled by the fact that a man is comfortable only when he thinks he is. Air which, judged by chemical analysis, is impure, may feel fresh and sweet, and *vice versa*. The only legitimate function of the engineer is to produce and control specified movements of air and other effects, while it should be the duty of the physiologist and hygienist to specify what are healthy and comfortable conditions. In connection with heating, the expression "temperature of a room" is generally understood to mean the reading of a thermometer suspended in the room, but this reading does not necessarily indicate the temperature of the surrounding air, or form a trustworthy guide to the feelings of the occupants of the room. The air temperature, the radiant temperature, the quantity of convected heat and the quantity of radiant heat must all be determined, but first the relation between the thermometer reading, the air temperature, and the radiant temperature must be determined. The freshness of air in a building depends on keeping the air temperature relatively low and the radiant temperature high. The chemical composition of the air has, within wide limits, no effect on the human organism, whereas its temperature and humidity are very important. The paper described experiments made at University College, London, and the apparatus used in connection with them, and discussed briefly some problems which it is sought to solve experimentally.

A paper on the distribution of heat in the cylinder of a gas engine was read before the Institution of Mechanical Engineers on May 14, by Prof. A. H. Gibson and Mr. W. J. Walker. The paper gives account of a series of tests made at University College, Dundee, in order to determine the jacket loss at different speeds. The engine, built by the National Gas Engine Co., Ltd., has a cylinder diameter of 11 in., and a stroke of 19 in. The water jacket is divided into two separate parts, one of which surrounds the exhaust-valve, and the other surrounds the breech-end and barrel of the cylinder. With the strongest mixture, and at full load, the percentage heat transmitted to the cylinder jacket is 1·10 times as great at 150 revs. per min. as at 250 revs. per min., while with the weakest mixture the ratio becomes 1·23. At 150 revs. per min. the period of contact per cycle, of hot gases and cylinder walls, is 1·66 times as great as at 250 revs. per min., and the rate of transmission of heat is evidently much greater at the highest speed. The indicator diagrams show that the maximum temperature attained in the cylinder is approximately 6 per cent. greater at 150 than at 250 revs. per min., so that the increased rate of transmission is obtained in spite of a lower gas temperature. The reason lies apparently in the fact that the greater turbulence of the working fluid at the higher speeds increases its effective conductivity to an extent which more than counterbalances the other factors.

OUR ASTRONOMICAL COLUMN.

Comet 1915a (Mellish).—Although Mellish's comet is brightening up, its large and increasing southern declination does not make it an easy object to observe in these latitudes. For the sake of those observers who are more favourably situated the following ephemeris, communicated by J. Fischer-Petersen (*Astronomische Nachrichten*, No. 4796), gives the positions up to June 5, when the comet attains its maximum brilliancy.

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
May 22	19 33 42	−35 12·3	
24	19 42 22	39 15·4	5·3
26	19 52 49	43 41·9	
28	20 5 50	48 27·7	5·0
30	20 22 30	53 29·7	
June 1	20 45	58 38	4·8
5	21 57	−68 10	4·7

In an appendix to No. 4800 of the *Astronomische Nachrichten* a telephone message to the Computing Bureau is reported from Prof. R. Schorr, stating that the nucleus of this comet has become divided into two parts, their magnitudes being 11 and 13, distance 20″, and position angle 291°. This fact was recorded on photographs taken by Dr. H. Thiele with the reflecting telescope of the Bergedorf Observatory.

Photographic Determinations of Stellar Parallax.—With the hope of making more accurate determinations of stellar parallax by means of photography, Mr. Adriaan van Maanen has been utilising the 60-in. reflector of the Mount Wilson Solar Observatory for this purpose. At present he has only completed the discussion of fine stars, and these promising results are briefly described in the Proceedings of the National Academy of Sciences (April 15, vol. i., No. 4). The following table gives the names of the stars, the parallaxes derived, the probable errors, and the number of exposures:—

	Star	Parallax ″	Prob. error ″	No. of exposures
Boss P.G.C.	96	+0·026	0·007	14
	672	−0·009	0·004	14
	1549	+0·001	0·001	16
	2921	+0·078	0·006	10
	3233	+0·003	0·010	12

Mr. van Maanen states that the mean probable error of a parallax for the mean of thirteen exposures is not quite 0·006″, and "if we compare this result with the best-known photographic determinations of parallaxes . . . it will be seen that we have gained considerably." He gives a list of these best-known parallaxes showing the mean probable errors in each case. Thus the four least probable errors from this list are as follows:—

Instrument	Observer	Mean prob. error ″	No. of exposures
Yerkes (40 in.)	Slocum, Mitchell	0·009	28
Yerkes (40 in.)	"	0·011	21
Swarthmore (24 in.)	Miller	0·011	?
Yerkes (40 in.)	Schlesinger	0·013	37

Report of the Kodaikanal and Madras Observatories.—The annual report of the director, Mr. J. Evershed, of the Kodaikanal and Madras Observatories, for the year 1914, has just come to hand. Reference is made in the first place to the expedition to Kashmir to test the suitability of the climate for solar research, the result of which was recorded in this column on December 24 last. A long list is given of the instruments belonging to the observatory, which list includes the instruments received from the Takhtasinghji Observatory at Poona. During the year a positive on negative spectrum comparator, constructed by Messrs. Hilger from designs by the director, was received, and also a diffraction grating ruled by Anderson, with ruled surface 9·7 × 12·8 cm., and total number of lines 75,085. This grating was immediately mounted in the large spectrograph, and "is the most perfect the observatory possesses, and it is now used in all researches where high resolving power is required." The work accomplished by the various instruments is next described. Under the heading of the spectroheliograph it is stated that the measures made from spectroheliograms will in future replace detailed observation at the telescope of the position angles and heights of the prominences. Summaries of sun-spot and prominence observations are given, showing that the solar activity was at a minimum in 1913. Eleven bulletins were published during the year. The report of the Madras Observatory describes the time observations and a general account of weather summary. The appendices contain tables of the seismic records at Kodaikanal and meteorological observations at both Kodaikanal and Madras.

Astronomy at Hampstead.—In the year 1899 the Hampstead Scientific Society was promoted for the study and encouragement of a popular interest in science, and at the present time there are three special sections of the society, namely, astronomical, natural history, and photographic. The report for the past year gives one a good account of the activity of the society, but, like many other societies, the disturbing influence of the war has been responsible for a smaller output of work. During the latter part of the year the enforced closing of the observatory rendered any observations impossible, but the attendance of members at the meetings fortunately did not suffer. The report of the astronomical section refers to the observational and theoretical work in connection with the planet Saturn, the new subsection of lunar detail, and the eclipse of the sun in August last. Brief accounts are given of the papers read at the meetings.

RECENT WORK IN APPLIED BIOLOGY.

Two recent numbers of the *Journal of Economic Biology* (vol. ix., 3, 4, 1914) contain an interesting article on the biology of sewage disposal, by J. W. Haigh Johnson, who points out that in sewage filters "the varying intensity of pollution between the crude sewage and the purified effluent would provide suitable conditions for the development of a range of organisms." The flora consists mostly of bacteria such as *Bacillus coli*, Zooglœa, and such fungi as Saprolegnia and Sporotrichum. On these feed larvæ of small hairy flies belonging to the genus Psychoda, which often swarm around sewage outfalls. Enormous numbers of the small blue-black springtail *Achorutes viaticus* form a characteristic and interesting feature on the surface of the liquid.

In the *Journal of Agricultural Research*, published by the United States Department of Agriculture, valuable biological papers constantly appear. In vol. ii., No. 6, E. O. G. Kelly describes a new sarcophagid parasite of grasshoppers. The female Sarcophaga "strikes" at the grasshoppers (species of Melanoplus and Schistocera) when flying, causing them to drop to the ground. She deposits tiny active maggots beneath the grasshopper's hind-wing. Thence they crawl to the metathorax and enter the victim's body through the soft cuticle at the wing-base.

The same number of the *Journal* contains an account, by F. Knab and W. W. Yothers, of *Toxotrypana curvicauda*, the "Papaya fruit-fly," the female of which, by means of an ovipositor as long as her body, lays eggs deep in the unripe fruit of the Papaya, where the maggots find an abundant and congenial food-supply. This mode of feeding, as is well known, is practised in oranges, lemons, peaches, etc., by larvæ of the notorious "Mediterranean fruit-fly" (*Ceratitis capitata*), which forms the subject of two papers in the *Journal* (vol. iii., Nos. 4 and 5), by E. A. Back and C. E. Pemberton. This fly is now a serious pest in the Hawaiian Islands, though it has not yet been introduced into the United States. Attempts are being made to introduce parasitic and predaceous insects that may keep the fruit-fly in check, and one of the papers just mentioned deals with this aspect of the question. Prof. F. Silvestri made last year a special journey to West Africa in order to study the natural enemies of fruit-flies, the results of which are described in the *Boll. Lab. Zool. Scuola Agric. Portici* (vol. v., 1914). Here may be found diagnoses with structural figures of a number of the destructive flies and of insects which prey on them, most of the latter being small Hymenoptera.

Our own *Bulletin of Entom. Research* maintains the high standard of its systematic and economic papers. In vol. v., pt. 3, lately issued, Dr. W. A. Lamborn's account of agricultural pests in Southern Nigeria opens new ground, and is well illustrated with a coloured plate of Lepidoptera and several photographs of injured plants. Stanley Hirst describes mites—mostly Dermanyssus and other Gamasidæ—found on rats in Egypt; while Rev. Jas. Waterston, turning for a while from Mallophaga, gives an account, with interesting structural figures, of new Chalcidoid fig-insects from Uganda. In the March number (vol. v., No. 4), just received, Mr. Waterston describes a number of parasitic Chalcidoids from tropical Africa and members of the same group from Ceylon. Among several useful papers in this number, S. A. Neave's account of the Tabanidæ of Southern Nyasaland, with descriptions of the early stages and bionomics of the species, is noteworthy. The *Review of Applied Entomology* is continued monthly, and contains excellent summaries of papers published in all parts of the world, agricultural entomology being contained in Series A, medical and veterinary subjects in Series B. In placing these publications within the reach of all students, the Imperial Bureau of Entomology abundantly justifies its existence. G. H. C.

MINERAL RESOURCES OF THE PHILIPPINE ISLANDS.

THE annual report upon the mineral resources of the Philippine Islands for the year 1913 has just been issued at Manila by the Division of Mines of the Government of the Philippine Islands. It gives evidence of fairly steady progress in the development of the mineral resources of these islands under American auspices. The value of the mineral production is estimated at just about 400,000*l.*, an increase of about 14 per cent. above that of 1912, but it must be remembered that these figures are made up, in accordance with the usual practice of the United States, from a number of items that are not generally included in the mineral statistics of other nations, such items as clay products, sand and gravel, and lime accounting for fully one-fourth of the total value. It is noteworthy that no coal was produced in the year under review, whereas the output for the year previous had been 2700 tons; there seems to be no good reason for this complete cessation of coal mining; it is true that one of the mines that had produced coal in 1912 had been drowned out apparently through careless driving into broken ground, which seems not to have been properly tested before the drift in question was put in.

Nearly one-half of the total value of the mineral output is due to the production of gold, of which 42,011 ounces were obtained, both quartz mines and alluvial mines having contributed to the total. The increase of production over 1912, when 27,582 ounces were produced, is relatively important; it is mainly due to dredging operations in the Pasacale district, where five dredges were at work, and where three additional ones were being constructed; it appears that the alluvial deposits are quite satisfactory, but that a shortage in the fuel supply, which appears hitherto to have been wood exclusively, threatens to become a serious problem in the near future.

The output of iron, in the form of castings direct from small native blast-furnaces, amounts to 227 tons, an increase of practically 50 per cent. above that in 1912. These castings are almost exclusively ploughshares; they were produced in ten furnaces, each of which averaged sixty-six days in blast throughout the year; they consumed 555 tons of 60 per cent. ore and 960 tons of charcoal, the iron extracted being thus just about two-thirds of the total iron present. It is interesting to note that this primitive method of iron-smelting is still able to hold its own in the face of imports of iron more than ten times as great as the total native production.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—The University has been concerned since its foundation with the question of residential accommodation for its students. Early in its history it received an important benefaction for the accommodation of women students in the shape of Clifton Hill House, to which the adjoining Callander House has since been added. During the past year the Imperial Hotel and a large property on Richmond Hill, Clifton, have been purchased for conversion into halls of residence for men and women training students. The University has now taken two houses for the purpose of a temporary residential college for men students. These houses are being renovated and decorated, and will be opened in good time for next term. When the arrangements are complete, the temporary college will start with accommodation for twenty-nine students.

GLASGOW.—His Majesty in Council has approved the Ordinance of the University Court, empowering the University to establish a degree of bachelor of science in applied chemistry. In conjunction with the Royal Technical College, which is affiliated to the University, courses in the various branches of chemistry relating to a wide range of arts and industries will be provided. The curriculum extends above four years, and the examinations will be of an honours standard.

More than 140 students in arts, law, and pure science have volunteered for service in the munition factories during the summer vacation. Arrangements have been made by the Appointments Committee with a number of firms on the Clyde, which are prepared to give employment of the kind to students who are not eligible for active service with the forces. When the sessional examinations are completed at the beginning of June, it is expected that at least 100 more students will undertake similar work.

LONDON.—A new edition of the University College "Pro Patria" is in course of preparation, and will be issued shortly. Past and present students, or their relatives and friends on their behalf, are invited to send full particulars of the capacity in which they are serving the country at the present time. In the case of the Army, rank and regiment should be given; in the case of the Navy, rank and ship. These particulars should be addressed to the Publications Secretary, University College, London (Gower Street, W.C.).

OXFORD.—The Halley Lecture will be delivered on May 20 at 8.45 p.m., in the hall of Queen's College, by Sir Frank W. Dyson, F.R.S., Astronomer Royal. The subject of the lecture, which will be illustrated with lantern-slides, is "The Measurement of the Distances of the Stars."

THE Year Book Press, 31 Museum Street, London, has been appointed by the Teachers' Registration Council as publishers of the first "Official List of Registered Teachers," which will be issued as soon as arrangements have been completed.

IN the issue of *Science* for May 7 it is announced that Mr. Andrew Carnegie's gifts to the Carnegie Institute and Institute of Technology—both at Pittsburgh—have now reached a total of 5,400,000*l*., his latest contribution, announced on April 29, being 540,000*l*. Of this latter amount 240,000*l*. is for new buildings, and 300,000*l*. for endowment. From the same source we learn that the campaign to raise 277,000*l*. for the Stevens Institute of Technology in Hoboken, N.J., has been concluded successfully. The entire indebtedness of the college, amounting to 77,000*l*., has been cancelled, leaving 200,000*l*. to be used for the erection of new buildings and for endowment. Gifts amounting to 14,580*l*., to be devoted to cancer research at the Harvard Medical School, have been announced. Of this sum 10,000*l*. is provided by the will of the late Mr. Philip C. Lockwood, of Boston. The legislature of Nebraska has granted 30,000*l*. for the erection of a teaching hospital for the University of Nebraska College of Medicine at Omaha, Nebraska.

THE Board of Education has issued a table of summer courses in England for instruction in many of the subjects of the school curriculum. The courses will be held on various dates during July, August, and September next. Nature-study appears to be one of the most popular subjects, and courses in it are being arranged at Ambleside, Bingley, Brighton, Falmouth, Great Yarmouth, Scarborough, Glastonbury, Newport, and Swanley. Geography, too, seems to be in great demand, probably in view of the growing popularity of practical methods of teaching the subject. Geographical courses are being held at Ambleside, Brighton, Cambridge, Oxford, and Sheffield. Courses in science will be held at Oxford, Wye, and Bangor, and at five centres there will be lectures on the theory of education. The official table states the authorities responsible for the courses, dates, fees, subjects of instruction, addresses for further particulars, and gives useful general remarks. Copies can be obtained through booksellers at a cost of one penny each. The war will reduce the facilities for foreign travel, and teachers who desire to combine further study with their recreation during the long vacation should study this pamphlet.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—Sir William Crookes, president, in the chair.—Elizabeth A. **Fraser** and Prof. J. P. **Hill**: The development of the thymus, epithelial bodies and thyroid in the vulpine phalanger (*Trichosurus vulpecula*).—Elizabeth A. **Fraser**: Some observations on the development of the thymus, epithelial bodies, and thyroid in Phascolarctos, Phascolomys, and Perameles.—J. H. **Brinkworth**: Measurement of the specific heat of steam at atmospheric pressure and 104·5° C., with a preface by Prof. H. L. Callendar. The measurement of the specific heat of steam in the immediate neighbourhood of 100° C. permits extreme steadiness in the conditions of observation, and is important as the starting point for the investigation of the variation of the specific heat with pressure and temperature, but presents special difficulties owing to the possible presence of water in suspension when the superheat is very small. The majority of determinations, such as those of Regnault (125°–225° C.), and Holborn and Henning (110°–270° C.), have been made with highly superheated steam, and throw little light on the value near 100° C. Those of Knoblauch and Jacob, and Knoblauch and H. Mollier, when extrapolated towards saturation, appear to indicate a very rapid increase in specific heat near the saturation point. The theory of the variation of specific heat with pressure is discussed in the preface in relation to some experiments by the Joule-Thomson method, the results of which were published in a previous communication. It is shown that the presence of only half-a-millionth of a gram-molecule of salt per gram of steam is sufficient to raise the apparent specific heat by 10 per cent. at 103° C., and that previous measurements near saturation were probably affected to a slight extent by this source of error. Special precautions were taken in the investigation to secure pure dry steam, and the conditions of experiment were varied widely, especially with regard to external heat-loss. By using a silvered jacket of silica maintained at a high vacuum, the loss was reduced to about a tenth of that in previous experiments, and amounted to only two or three parts in 1000 of electric energy supplied. The final result found was—$S=2030$ joules per gram per 1° C., at 760 mm. and 104·5° C., which is equivalent to 0·485 mean calorie under the same conditions, and is in good agreement with Regnault's result at 175° C., if allowance is made for the small variation deduced from the experiments by the throttling method.—C. F. **Jenkin** and D. R. **Pye**: Thermal properties of carbonic acid at low temperatures.—II. This is a continuation of the paper on the same subject published in the *Phil. Trans.*, A, vol. ccxviii., p. 67. It contains a description of (1) a series of measurements of the total heat of CO_2 gas from which the specific heats are deduced; (2) a few re-measurements of the total heat of liquid CO_2; and (3) a series of throttling experiments on CO_2 gas. By means of the first series the $\theta\phi$ chart, part of which was drawn in the former paper, is extended over the superheated gas area; its accuracy is then checked by means of the throttling experiments. Graphic methods are described for plotting the results of throttling experiments and thereby checking the specific heats of the gas and position of the gas-limit curve. Finally, an $I\phi$ chart is constructed for CO_2 based on the measurements described in both papers. To assist in the construction of this chart, a series of theorems connecting the total heat I with the other variables p, v, θ, and ϕ are worked out, and their use in checking the accuracy of $I\phi$ charts for any substances is explained. The authors hope that the new $I\phi$ for CO_2 chart, which extends and corrects Mollier's, may be of some technical value in the refrigeration industry.

Physical Society, April 23.—Dr. A. Russell, vice-president, in the chair.—Prof. W. B. **Morton** and Miss Mary **Darragh**: The theories of Voigt and Everett regarding the origin of combination tones. Voigt connects the existence of difference and summation tones with the fact that the stationary points of the compound vibration-curve, when the primary tones have equal energies, can be grouped in a certain way on sine curves, which recur in the periods of these combination tones. As against this view it is urged (1) that the same points can equally well be grouped on a whole series of curves with other frequencies; (2) that the distinctness of the combination-tones would on this theory vary greatly with phase-relationship of the primaries; (3) that the tones would disappear when the energies of the primaries are not very unequal. Voigt applies a similar method to the case where the upper tone is weak compared to the lower to account for Koenig's second beat-tone. The first of the above objections again applies. Everett supposed that the distortion of the vibration-curve in passing through the ear would bring in the note the frequency of which is the highest common factor of the primary frequencies. The effect of a special kind of distortion has been tested, consisting in a proportional reduction of ordinates in one direction. The result does not confirm Everett's contention, but shows the appearance of the summation and difference tones.—Miss Maud **Saltmarsh**: Experiments on condensation nuclei produced in gases by ultra-violet light. (1) Nuclei produced in air by ultra-violet light which has traversed a few centimetres of air are not affected by an electric field of 50 volts per centimetre. (2) The nuclei are equally effective in producing condensation of water, toluol, and turpentine vapours, and they are formed even by light which has traversed 50 cm. of air. (3) Alcohol vapour condenses without expansion on much smaller nuclei than does water vapour. (4) No nuclei were formed by the light unless oxygen or CO_2 was present in the gas. (5) No trace of H_2O_2 could be detected in the clouds formed on the nuclei. (6) Oxygen containing ozone also contains nuclei for condensation, and these nuclei have similar properties to those formed by ultra-violet light. (7) The nuclei can be destroyed by heating the air containing them. It seems probable that the nuclei formed by ultra-violet light do not cause condensation by virtue of any particular chemical composition, but that they are particles large enough to act like dust particles as centres round which condensation can begin.—S. **Butterworth**: The self-induction of solenoids of appreciable winding depth. The existing formulæ for coils of this type—viz., those of Rosa and Cohen—are shown to be inaccurate, the error amounting to one-fifth of 1 per cent. for the best formula when the winding depth is one-tenth the diameter of the coil. For greater winding depths the error is larger. The inaccuracy in Rosa's formula is due to the neglect of curvature in correcting for thickness, while in Cohen's formula the error is due to the approximate method of development. New formulæ are developed by methods which are free from such approximations, and which apply to any coil for which the length is greater than twice the diameter, and the winding depth is less than one-tenth the diameter. These formulæ are capable of giving eight-figure accuracy. Simplified formulæ are also given which are suitable when only four-figure accuracy is required.

Mathematical Society, May 13.—Sir Joseph Larmor, president, in the chair.—Dr. **Bromwich**: The diffraction of waves (i) by a wedge, (ii) by a circular disc.—W. E. H. **Berwick**: An invariant modular equation of the fifth order.—G. B. **Mathews**: A direct method in the multiplication theory of the lemniscate function.

MANCHESTER.

Literary and Philosophical Society, April 27.—Mr. F. Nicholson, president, in the chair.—Prof. W. H. **Lang**: Studies in the morphology of Isoëtes:—Part iii., The structure and growth of the rhizophoric region of *I. lacustris*, and the development and arrangement of the roots. Part iv., The progressive growth of the young plant of *I. lacustris*, and the nature of the cortical extension of the stock. In part iii. the structure of the rhizophoric lower region of the stock of *I. lacustris*; the nature of its meristematic growth; the way in which the segmentation of the growing line leads to the growth of a root-bearing surface, exposed by the progressive splitting, and to the carriage outwards of the roots initiated close to the meristem are described in detail. The organisation of the central vascular axis of the rhizophore behind the meristematic line is shown to correspond remarkably to that of the stem-stele as described in part ii. The arrangement of the roots, their exogenous insertion, and the course of the root-traces are compared with the corresponding features of Stigmaria. In part iv., the progressive growth and organisation of the young plants of *I. lacustris* are traced from the stage of an advanced embryo to that at which a small plant exhibits adult characters as regards root- and leaf-arrangement. The symmetry of the plant is only evident when the second leaf and second root are developed. Further roots arise from a meristem established at the base of the vascular axis of the shoot long before any cambial activity has begun. The rhizophore continues from this meristem as a region of progressive growth, bearing roots acropetally. It may correspond strictly to the root-bearing region in Lepidodendreæ. The primary root in Isoëtes is lateral to the axis of the rhizophore; the construction of the plant thus appears fundamentally distinct from the Gymnosperms and Angiosperms, where the first root continues the axis of the plant and behaves as a tap-root. The progressive cortical growth of the young plants of Isoëtes appears to continue uninterruptedly into that of the adult stock.

May 11.—Prof. S. J. Hickson, president, in the chair.—Dr. Arthur **Harden**, Prof. W. W. Haldane **Gee**, and Dr. H. F. **Coward**: A report on the Dalton diagrams. A report on a collection of about 150 original pen-and-ink diagrams used by John Dalton. They describe the elementary principles of mechanics, heat, optics, and astronomy; the laws of expansion by heat; the special scale of temperature used by Dalton; meteorological subjects; and chemistry and the atomic theory. The diagrams dealing with the atomic theory show that Dalton used graphic formulæ for "compound atoms" much more frequently than would be suspected from a study of his printed books or note-books. Many sheets illustrate the atomic composition of inorganic and organic substances. The latter are almost completely ignored in Dalton's published works, and in consequence his representation of them would be unknown at the present time were it not for the information disclosed by these diagrams. The formulæ are, however, very different from those now accepted. One of the diagrams is a list of atomic weights and symbols made in 1807, and is, so far as is known, the second list presented in public by him.

PARIS.

Academy of Sciences, May 10.—M. Ed. Perrier in the chair.—E. **Bompiani**: The equations of Laplace with equal invariants.—G. H. **Hardy**: The problem of divisors of Dirichlet.—Et. **Delassus**: The holonomial movements with multiple forms of Bagrange.—G. **Chesneau**: Contribution to the study of coloured glass of the Middle Ages. Analyses of violet, blue, green, and red glass, dating from the end of the thirteenth century, from Rheims Cathedral. The oxides of copper, nickel, cobalt, manganese, and iron were used as the colouring materials.—J. **Bougault**: The dioxytriazines. The synthesis of substituted semicarbazides. A method for preparing asymmetrical dioxytriazines has been given in a previous paper. These behave as acids towards alcohols, and give mono- and di-ethers in which the alkyl group is attached to nitrogen. The mono-alkylbenzyldioxytriazine on hydrolysis with boiling alkaline carbonate solution gives the alkyl-semicarbazone of phenylpyruvic acid, and this, treated in the cold with strong hydrochloric acid, gives the chlorohydrate of the alkylsemicarbazide. The method appears to be general, and descriptions are given of methyl-, benzyl-, and ethyl-semicarbazides.—Œchsner de **Coninck** and M. **Gerard**: Some basic salicylates.—Amé **Pictet** and Maurice **Bouvier**: The saturated hydrocarbons of vacuum tar. The raw material for this work consisted of 60 kilograms of tar distilled from one and a half tons of coal under a pressure of 15 to 20 mm. The unsaturated hydrocarbons were separated by means of liquid sulphur dioxide instead of with fuming sulphuric acid, as in the preceding note on the same subject. Six saturated hydrocarbons have been isolated, two being identified with certainty as hexahydrodurene and hexahydromesitylene, and the remainder are probably homologues of *cyclo*hexane. The same hydrocarbons have been isolated by Mabery from Canadian and Californian petroleums.—G. **Murgoci**: Rhodusite and abriachanite. These two minerals are the extreme ferric terms of the glaucophane series.—Const. A. **Kténas**: The iron minerals of igneous origin of eastern Greece and their transformations.—Stanislas **Meunier**: Mechanical phenomena as a factor in the elaboration of crystalline rocks.—N. **Arabu**: Studies on the Tertiary formations of the basin of the Sea of Marmora. The distribution of the faces in the different stages of the Tertiary; sketch of the tectonic of that region.—J. **Deprat**: The intermediate folded zones between Yunnan and Haut-Tonkin.—Eugène **Pittard**: Comparative anthropometry of the Balkan peoples.

BOOKS RECEIVED.

Evolution and the War. By Dr. P. C. Mitchell. Pp. xxv+114. (London: J. Murray.) 2s. 6d. net.

Life-Histories of African Game Animals. By T. Roosevelt and E. Heller. Two vols. Vol. i. Pp. xxviii+420. Vol. ii. Pp. x+421–798. (London: J. Murray.) 42s. net.

Brazil (1913). By J. C. Oakenfull. Pp. viii+604. (Frome: Butler and Tanner.) 7s. 6d. net.

Annuaire Général de Madagascar et Dependances (Supplément à l'Annuaire 1914). (Tananarive: Imprimerie Officielle.)

The Body in Health. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix+324. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 3s. 6d.

The Magic of Experience. By H. S. Redgrove. Pp. xv+111. (London: J. M. Dent and Sons, Ltd.) 2s. 6d. net.

The World's Cotton Crops. By Prof. J. A. Todd. Pp. xiii+460. (London: A. and C. Black, Ltd.) 10s. net.

Short English Poems for Repetition. By C. M. Rice. Pp. xv+119. (Cambridge: W. Heffer and Sons, Ltd.) 1s. 3d.

Elements of Optics for the Use of Schools and Colleges. By G. W. Parker. Pp. 122. (London: Longmans and Co.) 2s. 6d.

Symbiogenesis. By H. Reinheimer. Pp. xxiii+425. (Knapp, Drewett and Sons, Ltd.) 10s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, MAY 20.

ROYAL SOCIETY, at 4.30.—The Corpuscular Radiation Liberated in Vapours by Homogeneous X-Radiation: H. Moore.—The Absorption in Lead of γ Rays Emitted by Radium B and Radium C: H. Richardson.—The Application of Interference Methods to the Study of the Origin of Certain Spectrum Lines: T. R. Merton.

ROYAL INSTITUTION, at 3.—The Movements and Activities of Plants: Prof. H. Blackman.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Physical Condition of Cassiterite in Cornish Mill Products: the late J. J. Beringer.—Note on the Concentration of Gold in Bottoms in the Converter: H. F. Collins.—The Morro Velho Method of Assay of Gold-Bearing Cyanide Solutions: D. M. Levy and H. Jones.—The Effect of Different Methods of Crushing on the Ash of Coke: F. A. Eastaugh.

AERONAUTICAL SOCIETY, at 8.30.—Wilbur Wright Memorial Lecture—The Rigid Dynamics of Circling Flight: Prof. G. H. Bryan.

FRIDAY, MAY 21.

ROYAL INSTITUTION, at 9.—Beauty, Design, and Purpose in Foraminifera: E. Heron-Allen.

SATURDAY, MAY 22.

ROYAL INSTITUTION, at 3.—Colouring Matters of Nature: Dr. M. O. Forster.

TUESDAY, MAY 25.

ROYAL INSTITUTION, at 3.—Dyes, the Creation of the Chemist: Dr. M. O. Forster.

ZOOLOGICAL SOCIETY, at 5.30.—A Blood-sucking Gamasid Mite parasitic on Couper's Snake: S. Hirst.—A List of the Snakes of Madagascar, Comoro, Mascarenes and Seychelles: G. A. Boulenger.—Anatomical Notes on the Gruiform Birds *Aramus giganteus*, Bonap, and *Rhinochetus kagu*: Dr. P. Chalmers Mitchell.

THURSDAY, MAY 27.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 28.

ROYAL INSTITUTION, at 9.—Engineering Problems of Mesopotamia and Euphrates Valley: Sir John Jackson.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Evolution of the Oil Tank-ship: H. Barringer.

PHYSICAL SOCIETY, at 5.—Numerical Relations between Electronic and Atomic Constants: Dr. H. S. Allen.—A Method of Calculating the Absorption Coefficients of Homogeneous X-Radiation: H. Moore. Two Experiments Illustrating Novel Properties of the Electron Currents from Hot Metals: Prof. O. W. Richardson.—High Permeability in Iron: Prof. E. Wilson.

SATURDAY, MAY 29.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

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THURSDAY, MAY 27, 1915.

THE SCIENCE OF VULCANOLOGY.

The Problem of Volcanism. By Dr. J. P. Iddings. Pp. xvi+273. (New Haven: Yale University Press; London: Oxford University Press, 1914.) Price 21*s.* net.

THIS work is the latest published of a series issued by the Yale University, acting as trustees for the Silliman Memorial Fund; the fund consists of the sum of 85,000 dollars left to provide for the delivery and publication of annual courses of lectures "to illustrate the presence and providence, the wisdom and goodness of God, as illustrated in the natural and moral world." Although the terms of the bequest strikingly recall those of the once-celebrated "Bridgewater Treatises," yet the testators of the Silliman Fund qualify the statement of terms by a declaration of a belief that "any orderly presentation of the facts of nature or history contributed to the ends of this foundation more effectively than any attempt to emphasise elements of doctrine or of creed." In the end they conclude that dogmatic and polemical theology should be excluded, and that "the subjects should be selected from the domains of natural science and history, giving special prominence to astronomy, chemistry, geology, and anatomy." A comparison of the terms of the Bridgewater and Silliman foundations give a by no means unsatisfactory impression of the improved relations between the representatives of natural science and theology which have arisen in the course of the last century.

With characteristic impartiality the authorities of Yale University have invited representatives of various branches of science to give clear and up-to-date presentments of the condition of our knowledge on the subjects selected by them. The successive courses of lectures have been given by Profs. J. J. Thomson, Sherrington, Rutherford, Bateson, and Sir W. Osler from this country; by Profs. Nernst and Max Verworn from Germany; and by Arrhenius from Sweden; only three of the published courses, indeed, are by American men of science.

For the science of vulcanology no better representative could possibly have been found than Dr. Iddings, and no more striking illustration of the progress of investigation and theory could be given than his discussion of the problem. Fifty years ago the question was thought to be virtually settled by the assumption of a molten central mass constituting the earth's interior, or at least of pockets of such heated material at moderate depths; granted this, it was believed that all the explosive and eruptive actions of volcanoes could be accounted for by the access of sea-water to these incandescent materials through fissures in the earth's solid "crust." Now, after a full discussion of the astronomical, physical, chemical, and geological evidence involved, the author shows that there are no valid grounds against the conclusion that the earth's interior is solid and cold, and that all thermal action may be attributed to radioactivity, whilst many problems of far greater complexity than were ever thought of in the past await solution.

Although every outstanding branch of the inquiry meets with full and sympathetic treatment at the hands of the author, yet it is on the characteristics and relations of volcanic rocks that he writes with special authority, and more particularly on the light which has been thrown on petrology by microscopic research, the branch of study with which Dr. Iddings has been so long identified. But whether dealing with such problems as those belonging to his own studies or such varied questions as are suggested by the characters of nebulæ, Dr. Iddings is equally at home; and nowhere, to our knowledge, can there be found an account, so complete and illuminating, of all the varied lines of research bearing on the subject under discussion. A word of praise must be added for the numerous and beautiful illustrations, while the printing of the work exhibits all those excellences which we are accustomed to find in scientific works issued in the United States.

J. W. J.

LIQUIDS UNMATHEMATICALLY TREATED.

(1) *The Dynamics of Surfaces: an Introduction to the Study of Biological Surface Phenomena.* By Prof. L. Michaelis; translated by W. H. Perkin. Pp. viii+118. (London: E. and F. N. Spon, Ltd., 1914.) Price 4*s.* net.

(2) *Motion of Liquids.* By Lieut.-Col. R. De Villamil. Pp. xiv+210. (London: E. and F. N. Spon, Ltd., 1914.) Price 7*s.* 6*d.* net.

(3) *Liquid Drops and Globules: Their Formation and Movements.* By C. R. Darling. Pp. x+83. (London: E. and F. N. Spon, Ltd., 1914.) Price 2*s.* 6*d.* net.

(1) THE first part of the title of Dr. Michaelis's book is erroneous and misleading, for a mathematical physicist will fail to find anything whatever in these pages dealing with the dynamics of surfaces. It treats entirely of certain physico-chemical and electrical phenomena connected mainly with surfaces of separation of different media, and it makes no attempt at a rigorous theoretical investigation of these. As an illustra-

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tion of the style in which the subject matter is treated, about seventeen pages are devoted to a discussion of surface tension of a far more elementary character than is usually presented to an average B.Sc pass candidate working in the laboratories of a British university, and on the other hand the thermodynamical formulæ which follow are written down without any consistent attempt at lucid explanation. Had the book been described under the last portion of the title alone it is not improbable that it might have proved of use to biological students who are weak in their knowledge of physics and chemistry, but even they would do well to remember that a little learning is a dangerous thing, and the danger is greatly increased when this small cargo of information is allowed to sail disguised under the flag of a highly mathematical treatise.

(2) In the matter of sailing under misleading colours, Col. De Villamil is another delinquent. He recently published an "A.B.C. of Hydrodynamics" containing little or nothing on that subject which would be of use to a student pursuing a university course of study in hydrodynamics. By adopting a title closely resembling that of Lamb's classical treatise, he thrusts on our attention a small book devoted almost exclusively to common or garden *hydraulics*, and dealing far less with the actual motions of the fluids than with the resistances which they exert on solids. Many of his statements are not very clearly expressed; for instance, what does he mean by saying that "in an incompressible liquid which *has no free surface and whose envelope is inextensible all bodies moving in steady motion in it are stream-line*"? (p. 199), or, again, that "if any flat body *of any shape* be caused to move *irrotationally* round a fixed point, *every point in the body* will describe a figure which is an *inverted reflexion* of the body moving"? (p. 205).

Had Col. De Villamil claimed to write about "Practical Hydraulics," it is probable that a good deal of the subject matter of the book would have been of use to engineers. In posing as a mathematical physicist the author is probably defeating his own ends.

(3) Mr. Charles Darling's lectures on "Liquid Drops and Globules" present to an unscientific reader a simple and lucid exposition of a number of pretty experiments on liquids, many of which can be repeated by the most uninitiated at a trifling expense. The apparatus required is mostly of the simplest possible character, though for lecture purposes a lantern attachment is necessary. We note the author's recommendation of tap-water as superior to "distilled water, which often possesses a surface so greasy as to retard or even entirely prevent the desired result." Curiously enough, the present reviewer's experiences in spreading diatoms on cover glasses have confirmed this difficulty of greasiness, and for mounting in resinous media the best results were frequently obtained by evaporating from a thick convex drop of ordinary filtered water heated to a high temperature, the impurities in the water being deposited round the edge of the cover, where they could be wiped off. The greasiness so often present in distilled water frequently caused the drop to tear away from the edges of the cover long before it had became reduced to a mere film, and often left actually more deposit on the diatoms than the less pure liquid. The same occurred when the drop was initially too thin.

Readers who are unable to specialise in science, but who wish to interest themselves in some of its developments, can do no better than study a book of this kind. The experiments described form a delightful recreation for those engaged in duties of a non-scientific character, and at the same time they are directed on such lines as are likely to give them the closest insight into the intricacies and difficulties of scientific investigation. G. H. B.

INSECTS AND MAN.

(1) *Flies in Relation to Disease—Bloodsucking Flies.* By Dr. E. Hindle. Pp. xv + 398. (Cambridge: At the University Press, 1914.) Price 12*s*. 6*d*. net.

(2) *Insects and Man.* By C. A. Ealand. Pp. 343. (London: Grant Richards, Ltd., 1915.) Price 12*s*. net.

(1) THIS book is an attempt to combine in one volume the entomological information required by the doctor and the medical facts required by the entomologist, with regard to bloodsucking flies and the diseases they carry. The literature on this subject, being a special one, is very large, and is being added to daily. The whole subject is one that dates back only twenty years, and to attempt to present in a small compass a summary of these two aspects is no easy task. To do it successfully requires exceptional judgment in selecting what to omit and what to include, as well as a first-hand knowledge of both aspects of the subject. There is no evidence that the author has the latter, and the volume bears the impress of the laboratory, not of the tropics where these insects live and where men die daily from the diseases they carry. No one with actual tropical experience would omit from an account of measures taken against mosquitoes the use of traps and fumigants; no one with a first-hand

knowledge of insects would deal with technical points of entomology as is here done; the frontal suture is mixed up with the frontal lunule, the different venation systems are not tabulated, the value of the antennæ in classification is not made clear, there is an error about peripneustic, and so on. The volume, so far as the entomology goes, is largely a selection from Sharp's "Insects" (Cambridge Natural History) and Alcock's "Entomology for Medical Officers." These excellent works are, of course, listed in the references, but there does not seem to be any obvious reason for summarising parts of them.

The medical and the entomological student will find the references valuable. The doctor or sanitary officer who is not seeking special knowledge will find the volume a surprising revelation of the great importance attaching to this branch of entomology, and we wish it might do much to educate public opinion on this very vital point.

That is so more especially in England, where it is impossible to realise the part played by insects and the importance of these diseases. In this respect accuracy of technical detail and an up-to-date summary of the scientific aspect is less important than picturesque description and lucid writing, both characteristics of this volume. We commend it to the public which reads general science, and to medical men desirous of keeping their knowledge of this subject up to date. It is well illustrated and produced, and an exceedingly readable volume.

(2) The author has put together a series of abstracts of published works on various phases of economic entomology under chapter headings such as "Insects and Human Disease," "Insects and Plants," "Beneficial Insects," and so on. In the main, the work to which attention is given is that of the American worker, and the volume as a whole is very largely taken up with selections from recent American authors. The selection of subjects is curiously uneven: quite obscure household pests are mentioned, while really serious ones are omitted; the bee as a honey-producer and the silk-worms are omitted while the Chinese wax-insect is discussed. In agricultural and horticultural entomology one gets the impression that, while much progress is being made in America, none is being made elsewhere. The Americans are quoted as the pioneers in the use of parasites to control pests, while the pioneer work of Perkins in Hawaii is not referred to.

The author lays no claim to first-hand knowledge of the subject, but has clearly read voluminously from American works. His abstracts are well written, but the accuracy due to personal knowledge of the subject is conspicuously absent. No one would contend, for instance, that "the control of scale insects and aphides, therefore, in such districts practically resolves itself into control of the ants," though the Argentine ant is, of course, a factor in spreading scale insects; nor would anyone conversant with the literature say of the codlin moth, "no insect of economic importance has received so much attention from entomologists." The curling of the leaves of Prunus is not caused by the fungus that lives on the secretion of the aphides; only a portion of the Coccidæ cover themselves with a scale; in no insect is the duration of the life-cycle to be "counted in hours"—and so on. It is far too easy to find misleading statements in general, which would not occur to an author who had other than a purely book knowledge. We would have suggested that to the title might be added the words "The romance of," for one feels that it is the "romantic" element of the journalist that guides the choice of subject; picturesque detail and local colouring is the object sought, and no methodical attempt has been made really to "compile a concise summary of the varied relations of insects and man," as the author claims (page 21). A great deal is said about certain sections of the subject, but the ground is not covered in any complete or methodical manner.

It is probably inevitable that a new subject will be exploited by the journalist seeking picturesque "copy," but we hope it will not again be presented in a serious form calculated to mislead the student into thinking he has a concise summary of the subject; and if we must have such books as this, let us hope they will take into account the work done in this country and in our Colonies, every whit as good, though less blatantly set forth in sober reports, with no touch of the American journalese. We have to do a great deal yet to educate the British public (particularly the ruling class) to make them realise that there is a big future for economic entomology, but it will not be done by quotation from American entomologists, and the implication that they and they only can do the work. H. M. L.

CULTURE AND METAPHYSICS.

(1) *German Culture: the Contribution of the Germans to Knowledge, Literature, Art, and Life.* Edited by Prof. W. P. Paterson. Pp. x+384. (London: T. C. and E. C. Jack, 1915.) Price 2*s*. 6*d*. net.

(2) *The Principles of Understanding: an Introduction to Logic from the Standpoint of Personal Idealism.* By H. Sturt. Pp. xiv+302. (Cambridge: At the University Press, 1915.) Price 5*s*. net.

(3) *Essays Towards a Theory of Knowledge.* By A. Philip. Pp. 126. (London: G. Routledge and Sons, Ltd., 1915.) Price 2s. 6d. net.

(1) THE term *Kultur* is the equivalent of our "civilisation"; *Kulturgeschichte* is "history of civilisation." In a secondary sense the German term is narrowed to mean "the organisation of a people's life in which the ideals of religion, morality, and science come to realisation." The popular present-day use of the term, therefore, actually coincides with our "culture," "civilisation viewed on its higher side." It is only Chauvinist writers who have reduced it, at a very ill-chosen time, to the connotation of morality.

The popularly written essays, which Prof. Paterson has brought together, on Germany's contribution to the world's culture have the merit of impartiality. It is a mistake to suppose, by way of a reaction from Germany's pretensions to pre-eminence, that her work is second-rate and second-hand, however industrious.

In philosophy Mr. Lindsay observes that the German genius is supreme in the production of metaphysical systems. Such work suits the German mind, which has produced both "the dry-as-dust and the romantic fairy-tale." "The first question a German asks about a philosopher is—'What is his *Weltanschauung*?'"—his "world-vision." Could we talk about the world-vision of Locke or Hume? Mr. Lindsay is probably right in regarding German philosophy as "the most characteristic contribution which Germany has made to the common treasure of the human spirit." A typical feature of it is the passion for monism, Kant alone being an exception.

The best and most detailed essay in this book is that on science by Prof. J. Arthur Thomson. "It is probable that the Germans in their normal condition have the most orderly minds in Europe," but they have made far-reaching discoveries as well. Prof. Thomson sketches fully the course of investigation in biology, physics, and chemistry during the last hundred years, and places the German contributions in the order of their appearance, so that the reader may estimate their importance and compare them with those of other peoples. In biology the cell-theory, which "must be placed beside the evolution theory as one of the foundation-stones of modern biology," was almost entirely the work of Germans. An interesting episode of chemistry is this:—

"Sixty years ago an obscure German chemist obtained an oily liquid from coal-tar oil, which gave a beautiful tint with calcium chloride; five years later, another separated a similar liquid from a derivation of coal-tar oil."

Hofmann identified these with Zinin's oil of indigo, and called them by his term "Anilin." Perkin made the practical application of this knowledge, and

"the industry started by Perkin's discovery passed from Britain to Germany, but the honours of scientific discovery were shared by both countries."

Prof. Thomson concludes with a useful qualification:—

"the probable fallacy of using the history of science as an index of national or racial qualities," but he notes that "the reading public for concrete science is enormously greater in Germany than in Britain, and that there is a stronger faith (which we believe to be warranted) in what science can do for the amelioration of human life."

In Prof. Sadler's account of education two points may be marked:—

"England hesitated between two opposing theories, the theory of State control and the theory of group autonomy under the general supervision of the State. Germany came to a decisive conclusion on this fundamental question of procedure. Great Britain (and particularly England) remained divided in conviction about it, and therefore irresolute in policy. Germany standardised her education upon a system. Britain, distrustful of State control, compromised."

Not only English, but German observers have often remarked that the intellectual apprehension of the average educated German is ten times quicker than that of the average educated Englishman. But the intellectual judgment of the average educated German is most uncertain and weak, and often most conventional. The German will form ten foolish inductions to the Englishman's one. This corresponds to a real difference in temperament, between the cool, phlegmatic Briton and the emotional German. One result of this emotionalism seems to be the extraordinary solidarity of both German culture and German national feeling; yet British solidarity is as real, though longer-circuited.

(2) After the results of understanding, the principles of it, and the principles of the reality which we try to understand. Mr. Sturt writes from the point of view of personal idealism, and treats logic dynamically. His main text is the creative, inventional power of understanding. The foresight of understanding he advances as the strongest argument against epiphenomenalism, such as that of Shadworth Hodgson, according to which

"all the facts of consciousness are negligible by-products of physico-chemical energies in the nervous system." So Mr. Sturt says "no physico-chemical energy ever foresaw anything. It is consciousness, then, that foresees and plans."

But he does not explain consciousness. Consciousness, again, is characterised by passion; by neglecting this fact and the fact that it is "total-working," intellectualism "has obscured the true nature of intelligence."

On the fundamental nature of consciousness, creative and passion-wrought, Mr. Sturt has a big assumption, already made by McDougall, viz., "a true logic is impossible without animism." He has some interesting observations and phrases:—

"Felicitous naming, felicitous phrasing add enormously to the power of thought," especially, we may add, when thought is being thought about. Thus, the soul is not weak and shadowy, a slender breath, *animula vagula blandula,* nor a mere point; "a human soul is very large"; it has a wealth of faculties "correspondent to the richness of the world."

If the soul is a big thing, then the mental sciences, including logic, are bigger than the writers of the past would lead us to suppose. But Prof. Stout has said, "to the psychologist the conception of a soul is not helpful." Further, there is a social soul; a society of a hundred individuals is more than a hundred souls. On the "generation" of souls he says:—

"There must be some source of soul-life . . . we cannot say that we are not surrounded by a soul-element, and that the whole universe is not pervaded by soul-life whence individual souls come into being as they are wanted."

This is precisely the doctrine of the Dayaks and other savages of the East Indies.

(3) "Dynamic" is nowadays a blessed word. It assists Mr. Philip towards a theory of knowledge. In this, the ultimate reality is "potential energy." "Sensation is obstructed action"; "sensations only mark the interruptions in the dynamic activity in which we as potent beings partake." But these obstructions do not constitute the essence of our experience, they merely denote it. For this essence we must look to our activity as such. Space is the absence of physical obstruction. Time is the periodicity of natural force. Mr. Philip has some useful inferences drawn from the experiences of the blind, recently recorded by M. Pierre Villez. Particularly significant is his insistence throughout the book (which contains four short essays) on the necessity for metaphysics to found upon physics, a necessity hitherto almost totally ignored.

A. E. CRAWLEY.

OUR BOOKSHELF.

Canadian Institute: General Index to Publications, 1852–1912. Compiled and edited by J. Patterson (Hon. Secretary). Pp. 518. (Toronto: University Press, 1914.) Price 5.00 dollars.

THE pioneers of a new country are mainly preoccupied in developing its material resources, but there is always a remnant faithful to the intellectual life. Cut off from the companionship of their peers, these men gather themselves into local societies, and adopt the common form of regular meetings for the reading of papers.

Some two score such societies were scattered through the Dominion when, in 1882, the Marquis of Lorne founded the Royal Society of Canada. The older societies were not superseded, but affiliated, and they report annually by delegates on their work for the year. The most important of them were the Natural History Society of Montreal (founded 1827) and the Canadian Institute of Toronto (1852). It is this latter body which now issues, in a handsome volume of 518 double-column pages, an index to its 35 volumes of publications from 1852–1912.

The index has been prepared with much care and labour, the most important papers being indexed almost by paragraphs, and as it is arranged like a dictionary, alphabetically, it ought to be easy to find anything to which there is the slightest clue.

The pity of all such series is that they become the burial-ground of much that is valuable beneath heaps of rubbish. There are hundreds of references here to "papers" (especially in the early volumes) which are merely translations of some passage from the classics, fugitive reviews of forgotten books, scraps of antiquarian lore from anywhere on earth except Canada. But the real core of value is to be found in the original contributions on the history, customs, and folklore of the rapidly vanishing Indian tribes; the early history and settlement of Canada; its geology, minerals, botany, flora and fauna, with their consequent biological problems. Even in physics, though most that is worth while finds its way to European publications, there are observations special to Canada (*e.g.*, peculiar ice-formations) which would have found no record without the labours of her own pioneers of science. Distinguished names like those of Sir Daniel Wilson, Sir J. W. Dawson, and Goldwin Smith are a guarantee that there is much in these Proceedings which ought not to be smothered. This index will enable any student, in spite of the dust, to rescue whatever concerns his own line of study.

Towards Racial Health. By Norah H. March. With a Foreword by Prof. J. A. Thomson. Pp. ix + 326. (London: G. Routledge and Sons, Ltd., 1915.) Price 3*s*. 6*d*. net.

IN this little book Miss March deals with one of the most serious difficulties which lies in the path of those engaged in training the young. Children are taught elementary rules of health in relation to food, drink, and exercise, but sex is seldom mentioned. The majority of young people are left to find things out for themselves, or from their equally blind or ignorant fellows. The danger of this method, especially in the early days after puberty, when bad habits formed are so difficult to eradicate subsequently, is recognised by educationists, but, as a rule, nothing is done to counteract the evil. Miss March shows that instruction on this most important matter can be given without any loss of delicacy, by making biology a school subject, and by practically studying the development of certain plants and animals. She also very rightly urges that there should be greater frankness and confidence between parents and their children, and that reticence on the part of either should be discouraged. Great pains have been taken to make the biological statements clear and accurate.

The book is addressed to parents and teachers, not to the children themselves. There are many subjects dealt with, such as prostitution and sexual diseases, which it is quite unnecessary for mere children to understand; the evils of the world will become apparent quite soon enough, and we feel sure that these evils would be less if only young men and maidens were, at an early stage, taught to understand and respect their own bodies. It is because Miss March has made a successful attempt to induce parents to realise their responsibilities that we welcome her book.

W. D. H.

The Theory of Measurements. By Dr. A. de Forest Palmer. Pp. xi + 248. (New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd., 1912.) Price 2.50 dollars or 10s. 6*d*. net.

The author has prepared this treatise on the theory of measurements to meet the needs of students in engineering and advanced physics, and to impress on them the importance of realising the significance and the precision of the measurements made.

In the first seven chapters the general principles of measurement, the nature and distribution of errors, and the methods which are employed to arrive at the most probable result, are set forth clearly.

Measurements of various kinds are discussed, to show the importance of determining the precision of the result obtained if the operation is to be of any real value.

A general discussion of errors, which is very clearly stated, leads up to the method of least squares, and throughout the subject numerical examples are worked out so that the student may see for himself the treatment of measurements and the errors which arise.

The second half of the book is devoted to a general discussion of the precision of measurements, to which the earlier chapters have formed a suitable introduction. It is in this portion that the author's aim to lead the student to test systematically the results which he obtains is best seen, and the guidance given for the adequate discussion of completed observations and of proposed measurements is most valuable.

The whole subject is clearly and comprehensively set forth, and is illustrated by numerous examples of physical measurements, which are fully worked out. The book is to be recommended to the student as a useful guide to the systematic discussion of measurements and the determination of their adequacy.

M.

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.]*

Supposed Horn-Sheaths of an Okapi.

Arriving in London after an absence of more than three years in the Belgian Congo I have been considerably surprised at what appears to have been a mistake on the part of Messrs. Gerrard, the taxidermists, in connection with the skin and skeleton of an okapi, one of a series obtained recently by me in the Ituri forest.

The okapi in question was sent to the director of the Tervueren Museum in Brussels, and afterwards forwarded by him to Messrs. Gerrard in London; the skin in one case, the skeleton in another. In the box containing the skeleton I had originally packed a number of other bones, including the skull of a very young waterbuck. These bones and the waterbuck skull were taken out in Brussels and retained for the museum according to agreement. Unfortunately, the detached horns of the young waterbuck seem to have been overlooked, and when found by Messrs. Gerrard it was assumed that they belonged to the okapi, with which, of course, they had nothing whatever to do. It would appear, moreover, from a letter in the columns of Nature of July 9, 1914 (vol. xciii., p. 479), that the late Mr. Lydekker supported Messrs. Gerrard in this belief.

If it is a fact that these two horn-sheaths were labelled as belonging to the okapi I can only say that this was not done by me or any of my servants in the Ituri, none of whom could speak or write anything but Kiswahili, and if any label had been attached in Brussels no doubt it would have been written in French. Nothing is mentioned in my register of specimens about horny-sheaths. On the contrary, I distinctly say, "Horns $1\frac{1}{4}$ in., skin-covered."

The extraordinary statement that the giraffe-like horns of an okapi, an animal far removed from the antelopes, could in any circumstances have horny-sheaths resembling those of the prongbuck, naturally aroused the interest of Sir E. Ray Lankester, whose knowledge of the anatomy of the okapi is unequalled. I am considerably indebted to him for going into the matter without waiting for my return, and dispelling the illusion. His view of what had probably happened, as stated in his letter to Nature (March 18, 1915), is perfectly correct, except as regards the "well-intentioned servant."

The whole of my series of seven okapi skins has now safely reached England, I am glad to say, having been, through the kindness of the Belgian Minister, sent direct to London from the West Coast, together with two skeletons and various soft parts preserved in spirit.

Altogether more than eighteen months were spent in the Ituri forest hunting this scarce and extraordinary animal, and searching for the hypothetical *Elephas pumilio* ("Elephant nairn"), accompanied each day by one of my friends, the little Bambuti pigmies, without whose co-operation and assistance I could have done very little indeed. Elephants were everywhere, but not a sign of any pigmy species could I discover in the Ituri.

On several occasions I saw the okapi alive, sometimes at very close quarters, but so ghost-like, wary, and elusive is it, so difficult to track, even for the little "animal men," and so difficult is it to see in the prevailing gloom, that I only succeeded in shooting two. A third one (No. 531) of the series was shot by Commandant Hedmark, an officer in the Congo service, who spent three days shooting with me at one of my forest camps, and came upon the animal quite by accident.

A fourth (No. 717) was killed, late one afternoon, in mistake for a buffalo, by Mr. A. E. H. Reid, a prospector, also in the Congo service, and given to me. This specimen is of considerable interest, being an old male with well-developed horns some 4 in. in length, and skin-covered except at the tip, where, instead of a tuft of hair, the bony horn-core is bare, somewhat cup-like in shape, and of modified, white, polished, very hard, compact bone. The remaining three skins were procured from natives and are very incomplete.

Hitherto there has been considerable confusion as to the sex to which the comparatively few skulls handled by naturalists belonged, and mainly for this reason there has been a doubt as to whether both sexes or only the male develops horns. There is no question as to the sex of four of my specimens, three males and one female. Two of the males have horns, but the third, being very immature, has not yet developed them. The big female, although an old animal, as shown by the condition of the teeth, has no horns or any signs of developing ossicones. This being so, I think I am justified in saying that my specimens go far towards proving that only the male okapi carries horns.

They also help to prove that the female okapi, unlike most other animals, attains a greater height and bulk than the male, a peculiarity suspected by a writer in *Country Life* (October 25, 1913) as the result of measurements of mounted specimens.

Giraffe-like as the animal seems, and is, it is only when extremely young that the backward slope of the back is very noticeable. It does not feed on any species of water-plant so far as I know. In fact, it seldom frequents low situations near the water. Its food consists of leaves of the undergrowth and young saplings, and in feeding it reaches to a considerable height, pulling down leafy twigs with its long prehensile tongue. It does not, I think, feed at night, but in the early evenings and the mornings until at least as late as nine or ten o'clock. It is not a jungle-loving animal at all, but prefers the higher and drier parts of the forest, where the trees are big and the undergrowth comparatively scanty. It has no skulking bongo-like habits, but is never seen in the open. When going away at speed its neck is held straight in front, and it will jump obstacles rather than go beneath them, like the bongo and the little red buffalo.

Everything points to the okapi being the progenitor of the giraffe, or at least there seems little doubt that both are from the same stock. The okapi certainly does not appear to me to have any affinities with the antelopes.

CUTHBERT CHRISTY.

Royal Societies Club, St. James's Street, S.W., May 24.

A Further Extension of the Spectrum.

IN NATURE of May 7, 1914 (vol. xciii., p. 241), I stated that I had extended the ultra-violet limit of the spectrum to the neighbourhood of wave-length 900 Ångström units.

I have now succeeded in carrying my observations to wave-length 600. This result is chiefly due to the use of helium of considerable purity in my spectroscope and discharge tube. The apparatus is the same grating vacuum instrument which I have employed for several years, but perfected in such a way as to make it much more nearly air-tight than ever before. The spectrum which is obtained with a disruptive discharge in helium contains, between wave-length 1250 and 600, upwards of fifteen lines, some of them of some strength.

My work with hydrogen confirms the existence of the series predicted by Ritz with members at 1216, 1026, and 972. But, owing to the great difficulty of obtaining the gas content of my spectroscope absolutely free from impurities, I am not even yet able to identify positively the source of certain strong lines which occupy the positions demanded by the analogue of the Pickering series, and occur both when hydrogen and when helium are employed.

THEODORE LYMAN.

The Jefferson Laboratory, Harvard University, May 11.

The Distribution of the Electrons in Atoms.

THE spectra which are obtained by the diffraction of X-rays by crystals are characteristic both of the substance which emits the X-rays and of the crystal which acts as the grating. If the lines of an accurately ruled plane grating are small in width compared with their distance apart, the intensities of the different orders of spectra are nearly the same. If, however, the lines have a width comparable with the grating constant, the intensities of the higher orders rapidly diminish. When a crystal diffracts a beam of X-rays, the different layers of atoms correspond to the lines of the ordinary transmission grating, so that the relative intensity of the higher orders of spectra will depend upon the ratio of the effective diameter of the atoms in scattering the X-rays to the distance between the successive layers of atoms.

There are good reasons for believing that it is the electrons in atoms which scatter the X-rays. On this assumption it may be shown that if the density of the space distribution of the electrons in each layer of atoms is some function $f(z)$ of z, where the z axis is taken normal to the reflecting planes, the ratio of the amplitude of the nth order spectrum to the amplitude it would have if all the electrons were in the same plane is:—

$$\frac{P}{P_0}=\frac{\int_a^b f(z)\cos(\beta+2\pi nz/d)dz}{\cos\left(\beta+\pi n\frac{b+a}{d}\right)\int_a^b f(z)dz},$$

where $b-a=d$ is the grating space, and β is the phase angle of the reflected ray. If it is possible to find some function $f(z)$ which will lead to the values of P/P_0 as determined experimentally, an indication will be obtained of the distribution of the electrons in the atoms.

W. H. Bragg has published experimental results (*Phil. Mag.*, vol. xxvii., p. 895, 1914) showing the rate of variation of the intensity with the order when X-rays are reflected from rock-salt. It can be shown from his data that the intensities of the different orders cannot be accounted for by assuming that the atoms in the salt crystal are made up of single rings of electrons, or by assuming a uniform volume distribution of the electrons in spheres. A distribution which fits Bragg's data acceptably is an arrangement of the electrons in equally-spaced, concentric rings, each ring having the same number of electrons, and the diameter of the outer ring being about 0·7 of the distance between the successive planes of atoms.

If, as D. L. Webster assumes (*Phys. Rev.*, vol. v., p. 238, 1915) the trains of waves of the primary beam of X-rays are short compared with the distance which the rays penetrate the crystal, certain corrections have to be applied to the experimental data, and on this assumption it can be shown that the average distance of the electrons from the centre of the atom is small compared with the distance between the atoms.

Experiments are now in progress to test the validity of Webster's assumption and to determine more accurately the rate of variation of the intensity of the reflected beam with the order. It is hoped that it will be possible in this manner to obtain more definite information concerning the distribution of the electrons in the atoms. ARTHUR H. COMPTON.

Palmer Physical Laboratory, Princeton, N.J., April 29.

I HAVE to thank the Editor for his kindness in allowing me to see Mr. Compton's letter. I believe Mr. Compton is right in ascribing the rapid decline in the intensities of the X-ray spectra as we proceed to higher orders to the fact that the atom should not be treated as a point, but as a distribution of electrons in space; if this is so, we may hope to determine this distribution when we have measured the relative intensities accurately and have learnt to interpret them. This hypothesis and its consequences were discussed by me in the Bakerian lecture given before the Royal Society in March last. As only short notices of the lecture have yet appeared in print, I may mention one or two of the points then raised.

It seems convenient to imagine a periodic distribution of density such as occurs in a crystal to be analysed by Fourier's series, in a manner suggested by previous work of Rayleigh, Schuster, or A. B. Porter (*Phil. Mag.*, January, 1906, p. 154). Each harmonic distribution of density is responsible for one order of reflection. The results of measurements with calcite seem to show that the intensity (not the amplitude) of the reflection by a "harmonic reflector" is proportional to the amplitude of the harmonic distribution of density; that is to say, that the intensity of the reflection is proportional to the mass of the reflector. It is necessary to explain, not only why the intensities of the various orders fall off approximately as the inverse square of the number of the order, but also why atom-bearing planes give intensities whose reflections are proportional to the squares of the distances separating the planes. It appears that both laws follow from the same hypothesis, viz. that which supposes the reflecting electrons to be distributed in space through the volume of the atom, and which imagines much overlapping to take place—atoms of one plane being thrust far into the interstices of the next.

Experiment seems to fit in with these ideas. Probably, however, it is necessary to take account also of a difference in the distribution in different atoms. For example, certain results seem to indicate that the sulphur atom is more concentrated than the zinc.

The University, Leeds. W. H. BRAGG.

Early Figures of the Remora.

As remarked by Dr. Albert Günther, in his article on the history of the Remora ("On the History of the Echeneis," *Ann. Mag. Nat. Hist.*, 1860, ser. 3, vol v., p. 386), "there is scarcely a fish of the existence of which the ancients have been equally certain, and which has so much occupied their imagination . . . as the Echeneis of the Greeks or Remora of the Latins." Also, the same author continues, "there is scarcely a group of fishes . . . which has been so little *comparatively* treated, and which has experienced a similar splitting up into nominal species."

The ancient legends associated with this fish, from which it derives its name, signifying "ship-holder," persisted until well into modern times; and what is probably the earliest illustration of the Remora in printed books shows several of these creatures engaged in arresting the progress of a vessel. The curious woodcut referred to is found in that late fifteenth-century work known as "Hortus Sanitatis," the author or compiler of which styles himself Johannes von Cube, or Cuba, by some thought to have been a punning pseudonym for Dr. Wonnecken, town

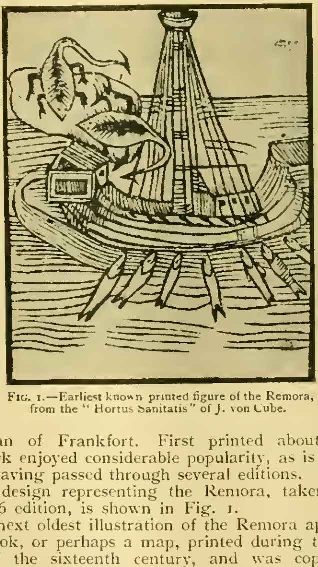

FIG. 1.—Earliest known printed figure of the Remora, from the "Hortus Sanitatis" of J. von Cube.

physician of Frankfort. First printed about 1490, the work enjoyed considerable popularity, as is proved by its having passed through several editions. A copy of the design representing the Remora, taken from the 1536 edition, is shown in Fig. 1.

The next oldest illustration of the Remora appeared in a book, or perhaps a map, printed during the first half of the sixteenth century, and was copied by Conrad Gesner in book iv. of his "Historiæ Animalium," published in 1558. It is shown in Fig 2. The same figure, more or less modified, reappears in various seventeenth-century works on natural history, as, for example, those of Nieremberg, Aldrovandi, Jonston, Ruysch, and others.

Search for the original after which Gesner's figure was copied has proved unavailing; but the subject of the sketch, and also the verbal description, are traceable to the account of a West Indian species of sucking-fish, the first printed description of which is found in the "Libretto" of Peter Martyr of Anghera, published in 1504, and reprinted three years later in the collection of voyages known as "Paesi novamente Trovati."

The source of Peter Martyr's information was undoubtedly Columbus himself, for we find the same fishing incident related, together with a more trustworthy description of a species of sucking-fish (probably *Echeneis naucrates*), in those fragments of the Journal of the second voyage of the great discoverer which have been preserved by his son Ferdinand, and by the chroniclers Bartolomé de Las Casas and Fray Andrés Bernádez.

Bernáldez, curate of Los Palocios, was a personal friend of Columbus, and had access to his Journals and other papers. Thirteen chapters of his history are devoted to the Admiral and his discoveries. In chapter 126 occurs an interesting passage relating to the Remora, which no doubt faithfully reproduces the famous navigator's own words. The only naturalist of modern times who has commented upon the incident in question, so far as the present writer has been able to find, is Alexander von Humboldt. Poey briefly refers to it in his description of the so-called *Echeneis guaican*, and Dr. Günther appears to doubt that the Remora was actually employed in the capacity narrated.

The passage in Bernáldez reads:—

"[At the Queen's Gardens, off the coast of Cuba] on the day following [May, 1494] the Admiral being very desirous to find someone from whom he might obtain information, there came a canoe to hunt for fish:—for they call it hunting, and they hunt for one fish with another. They have fishes of a certain kind which they hold by a line fastened to their tails, and which are like the conger-eels in shape; and have a large mouth armed with suckers, like the cuttle-fish. They are very fierce, like our ferrets, and when they are thrown into the water, they go to fasten themselves upon some of the fishes there, and sooner die than let go their hold, till they are drawn out of the water. The fish is very light, and as soon as he has taken hold, the Indians draw him by the long cord tied to his tail, and immediately throw him into the water again; and in this way, they take one every time. As these hunters were at a distance from the caravel, the Admiral sent his armed boats to them, contriving it so that they should not escape to land. As the boats came up to them, these hunters called out to the men, as unconcernedly as if they had known them all their lives, to stop, because one of the fishes had fastened upon a large turtle, and they must wait till they had got it into the canoe.

"This our men did, and afterwards they took the canoe, and those in it, together with four turtles, each of which was three *codos* long, to the ships of the Admiral; and there they gave some account of these islands, and of their cacique, who was close at hand, and had sent them to hunt. They asked the Admiral to go on shore, and they would make for them a great feast, and would give to them all four of the turtles."

C. R. EASTMAN.

American Museum of Natural History, New York.

FIG. 2.—The Remora or "Reversus" as described by Christopher Columbus. (After Conrad Gesner, 1558.)

A Mathematical Paradox.

"Two horses, side by side and four feet apart, run once round a race track. How much further does the outer horse go than the inner?"

If this question is asked, in nearly every case the immediate reply is that it depends on the size of the track. It is somewhat paradoxical that the distance is 8π, or a little more than 25 ft., is actually independent both of the size and of the shape of the race track, provided that there is no reversal of curvature.

This problem is stated in a more formal manner in Williamson's "Integral Calculus," namely, if two curves have the same evolute the difference of their lengths is $4\pi D$, where D is the distance between the curves.

A. S. E.

A Mistaken Wasp.

THE mistake made by the cabbage butterfly referred to in NATURE of May 20, appears to be made by other insects.

Quite recently (last week in April) whilst having lunch in a sunny room decorated with a light-coloured paper with a floral design of pink roses in full bloom, a large wasp entered and became very agitated; observing it for some little time, I noticed it alight every moment or so in the centre of one of the roses, remain a moment, then off again to another; it appeared to be getting very angry as it went from rose to rose, which it kept on doing during the time I was in the room—twenty minutes or so.

W. A. GUNN.

Corporation Museum and Art Gallery, Dock Street, Newport, Mon., May 22.

THE PENGUINERY RE-VISITED.[1]

THE author's fascinating popular account of the social life of the Adélie Penguin (*Pygoscelis adeliae*) has been already reviewed in these columns, but the subject is of such great interest and Dr. Levick is such a consummate observer that we make no apology for turning to this second and more formal publication in the hope of adding to the completeness of the picture previously presented.

Apart from the observations made by the late Dr. Edward A. Wilson, which may be accepted, we are told, as "entirely correct," previous descriptions of the life of the Adélie Penguins have failed to do justice to these wonderful birds. About the middle of October they appear in ones and twos on the beach at Cape Adare, and by the end of the month there may be three-quarters

[1] British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. i., No. 2. "Natural History of the Adélie Penguin." By Staff-Surgeon G. Murray Levick. Pp. 55-84+plates i-xxi. (London: British Museum (Natural History), and Longmans, Green, and Co., 1915.) Price 5*s*.

of a million (Fig. 1). They toddle along on the sea-ice at the rate of about two-thirds of a statute mile per hour, with about 130 steps to the minute, and this mode of progression they alternate with tobogganing on their breasts, using their legs as propellers (Fig. 2). Some of them stop on the low ground; others make straight for the cliffs and nest on the ledges. Dr. Levick found a colony established at the very summit, about 1000 feet above the sea, a site that involved a prodigious amount of labour later on when the young had to be fed. Several journeys up and down had to be made in the twenty-four hours, and the up-journey meant about two hours' strenuous climbing. Very interesting in its prescience was the entire avoidance of an attractive knoll rising out of a shallow lake near the beach. It was very suitable when the penguins came ashore, but later on it was surrounded by foul water slimy with guano, to wading in which the birds have a deeply-rooted objection. But how did they know? Another interesting fact was the occasional raising of nests which had been built too low, and were in danger of being flooded in thaw time.

Fig. 1.—A long line of Adélie Penguins approaching their breeding ground. From "Natural History of the Adélie Penguin."

In connection with the mating, with its deadly but never fatal encounters of rival cocks and the quaint approaches that the victor makes to the coy hen, the observer proved by marking the breasts with paint that couples remain perfectly faithful to one another all through the breeding season. Careful watching of marked nests showed that the shortest period of fasting (between the arrival at the rookery and the hatch-

Fig. 2.—Adélies walking and "tobogganing" over sea-ice to the Rockery. From "Natural History of the Adélie Penguin."

ing of the chicks) is about eighteen days, and the longest about twenty-eight days. The reason for the close-sitting is to guard the stones of the nest from being stolen, and to guard the young wives from the attentions of strange cocks. Consequent on the abstinence from food the excreta around the nest are bright green—the colour of the bile, and without the red guano which is deposited after the birds begin to feed. They depend solely on euphausias, somewhat prawn-like crustaceans rich in zoonerythrin.

When the eggs are laid one of the parents goes off for some days (up to seven or ten), and on its return the other partner has a similar respite. When the chicks are hatched the alternations are frequent. Very quaint is the way in which the parents often overload themselves with the euphausias with which they feed the young, so that they have to lean back to keep their balance. Sometimes the toil is too much for them, and they lose all their take and all their trouble at the last moment. For the chicks will not pick anything off the ground, or eat save in the proper way by thrusting their heads down their parents' throats.

The rate of growth is astonishing. Thus the egg weighed 4·56 ounces, the newly-hatched chick 3 ounces, the five days' old 13 ounces, the six days old 15·75, the eight days old 24·75, the nine days old 28·5, the eleven days old 37·75. When the chicks are about a fortnight old the parents "pool their offspring," leaving them in the care of domesticated individuals, while they enjoy themselves holidaying in the sea (Fig. 3) or on the ice. Of their "touch-last" and "excursion steamer" games, of their mortal fear of the voracious sea-leopard (*Hydrurga leptonyx*)—their only enemy in adult life save man and his dogs, of the high mortality among the young for which the voracious skuas and the vicious cocks are largely to blame, of the "ecstatic attitude" and "chant de satisfaction" which mark a high sense of well-being among the Adélies; of the toughness of the birds, seen, for instance, in their surviving being imprisoned for weeks in a superficially frozen snow-drift; of the puzzling "drilling on the ice," which may be a reminiscence of massing before migration; and of the autumnal farewell to the antarctic shores and the journey to unknown winter-quarters, the report itself must speak. The author has our felicitations.

FIG. 3.—Adélie Penguins "porpoising." From "Natural History of the Adélie Penguin."

THE ANTIQUITY OF HINDU CHEMISTRY.

THE *Panjabee* of February 23 contains a report of a lecture on the antiquity of Hindu chemistry, given before the Punjab University, Lahore, by Dr. P. C. Rây, of the Presidency College, Calcutta, which is of interest as demonstrating the origin of Indian chemistry and the influence of Hindu learning upon that of the Arabs and of European nations. Two thousand five hundred years ago the Hindus were skilled in the examination and valuation of gold and gems; in a knowledge of the colouring of gems and jewels, and in certain metallurgical processes. Long before the age of Paracelsus they recognised that chemistry was the handmaid of medicine, and that its development was intimately bound up with progress in the art of healing. As with the Iatro-chemists, Hindu chemistry became, for a time, the chemistry of mercury. In the *Sarvadarsansamgraha* of Madhavacharyya the chemistry of mercury ranks, indeed, as a separate system of philosophy. "By the science of mercury is to be understood not only a branch of chemistry, but as applicable even to salvation, since the partaking of mercurial preparations renders the body imperishable." From which we may infer that the Hindus were aware not only of the therapeutic virtues of mercurials, but had recognised their remarkable antiseptic and preservative properties. In fact, according to Dr. Rây, the history of Hindu chemistry is emphatically the history of the progress of chemical operations grouped round the preparations of mercury. So much is this the case that in ascertaining the age of a medical work or of a chemical Tantra it may be laid down as a fairly safe guide whether any mention of the use of mercury occurs in it, and, if so, in what particular form.

Dr. Rây gives a number of instances in which discoveries usually considered of Western origin are to be found noted in old Hindu treatises, such as those of Vrinda and Chakrapani. The Tantra, the "Rasarnava" (about 1200 A.D.), is a repository of chemical lore, with elaborate directions and details of the construction of apparatus, furnaces, hearths, etc., required for distillation, sublimation, calcination, extraction of metals, etc., and shows remarkable powers of keen and accurate observation, The necessity for experiments is strictly enjoined in most of these old works, and the value of the Baconian method and of the precepts of the "experimentarian philosophers" of the Royal Society of Charles II. was long ago recognised and appreciated by their Indian predecessors. Even the influence of the experimental method on teaching was not lost sight of. "They alone," says Dhundhukanatha, "are to be regarded as real teachers who can show by experiments what they teach. They are the deserving pupils who, having learned the experiments from their teachers, can actually perform them. The rest, both the teachers and pupils, are merely stage actors."

Verily one generation passeth away and another generation cometh, and there is no new thing under the sun.

T.

THE SUPPLY OF OPTICAL GLASS AND INSTRUMENTS.

OPTICAL matters, and technical education generally, continue to claim their share of public attention. Following upon the article which appeared in our issue of May 6 (p. 266) on the supply of optical glass, we had the important debate, published verbatim in our last issue, on the proposed Advisory Council on Industrial Research which arose on the education estimates. More recently, on the motion for the Whitsuntide adjournment on May 19, an important speech, which was entirely devoted to optical matters, was made by Sir Philip Magnus. The speech, so far as it related to the supply of optical glass, necessarily traversed the ground covered by our article of May 6, but added specific instances of the German "wire entanglements" woven round the optical trade.

The speech, however, went further, and dealt with the supply of optical instruments, treating in detail the economic and educational aspects of the question. On the economic side it was laid down as an axiom "that what is essential to the safety of the realm must be produced within the Empire." The questions of high tariff and of a bonus on production were referred to, but the suggestion most favoured advocated that it be an enforced condition of all Government contracts that every part of the optical instruments contracted for should be made in this country. With the Government trade thus secured, it was argued that German attempts to capture the whole industry must fail.

On the educational side, the country's requirements, which are well known to our readers, were summarised, but perhaps too little was made of the necessity, which is strongly supported by leading experts, for the provision of, at least, one place where the whole range, from the lowest to the highest, of teaching in applied optics shall be available. The final suggestion made was "that a small committee should be appointed to co-ordinate the work of" the National Physical Laboratory, the Imperial College of Science and Technology, and the Technical Optics Department of the Northampton Polytechnic Institute. Sir Philip Magnus was followed by two other speakers, but the debate was interrupted by the Prime Minister's important statement regarding a Coalition Government.

Later on, Dr. Addison replied sympathetically on behalf of the President of the Board of Trade, and assured the House that the "subject was being closely attended to, and that the Government hoped at a very early date to have a comprehensive scheme to deal with this somewhat complicated and technical question."

NOTES.

We regret to announce the death, on May 23, at eighty-one years of age, of Dr. Hugo Müller, F.R.S., past-president of the Chemical Society.

The death is announced, in his seventy-first year, of Dr. Joseph J. Hardy, who had held the chair of mathematics and astronomy at Lafayette College, Pennsylvania, since 1891. He was the author of "Analytic Geometry, Infinitesimals and Limits."

The Paris correspondent of the *Times* announces the death of M. Pierre Martin, the inventor of the Martin process of steel manufacture. It was only last week that we announced that the Iron and Steel Institute had just conferred on M. Martin the Bessemer gold medal for 1915.

The deaths are announced in *Science* of Prof. J. W. Seaver, for twenty-five years director of the Yale gymnasium, and professor of hygiene in the University, on May 5, at the age of sixty years, and of Mr. W. H. Reed, curator of the museum and instructor of geology in the University of Wyoming, noted for his collections of vertebrate fossils, who died at the age of sixty-seven years on April 24.

The Albert medal of the Royal Society of Arts for the current year has been awarded to Sir J. J. Thomson, for his researches in physics and chemistry, and their application to the advancement of arts, manufactures, and commerce. The Albert medal was founded in 1863 to commemorate the Prince Consort's presidency of the society, and is awarded "for distinguished merit in promoting arts, manufactures, and commerce."

Dr. E. O. Hovey, of the American Museum of Natural History, has just returned from a three months' expedition to the Lesser Antilles. The time was largely given to an examination of Mont Pelée, the Soufrière, and other volcanoes of this region. It is reported by Dr. Hovey that the activity of Mont Pelée has continually diminished since the great outbursts of 1902–3. On the east or windward side vegetation has re-established itself up to the very summit, and even the forest is beginning to reassert itself. The rocks of the new cone are more or less thickly coated with moss.

We announced last week the award, by Columbia University, of the Barnard gold medal to Prof. W. H. Bragg and his son, Mr. W. L. Bragg, for their researches in molecular physics and in the particular field of radio-activity. The Butler gold and silver medals have also been awarded. The gold medal is awarded every fifth year for the most distinguished contribution made during the preceding five-year period to philosophy or to educational theory, practice, or administration. The silver medal is awarded annually to that graduate of Columbia University who has, during the year preceding, shown the most competence in philosophy or in education theory, practice, or administration, or has during that time made the most contribution of any of these. The former has been awarded to the Hon. Bertrand Russell, lecturer and fellow of Trinity College, Cambridge, for his contributions to logical theory. The silver medal has been awarded to Prof. E. P. Cubberley, of Leland Stanford Jr. University, for his contributions to educational administration.

A suggestion for the defence of our soldiers against poisonous gas in the present war is made by Dr. F. C. Coley, of Newcastle-upon-Tyne, in a letter to the *Morning Post* of May 25. He proposes the use, in the trenches near enough to the enemy to be in danger from such gases, of rotary fan-blowers worked by hand placed at about every three or four yards. The fan-blowers should be connected with pipes going through the base of the earthwork in front of the trench. If the number of blowers were equal to the number of gas cylinders used by the enemy, the blowers when vigorously worked would deliver a far greater volume of air than the volume of the poisonous gas, so that the gas would become much diluted, and with good respirators would be harmless to our men. We believe that experiments are being conducted at the front with the object of devising means to render the poisonous gases innocuous by spraying with water and in other ways. The former expedient would require only a supply of water in the trenches and a spraying apparatus, and it would seem to afford an effective means of protection.

Mr. Richard Kerr, the genial and well-known lecturer on astronomy, microscopy, and other scientific subjects, died on May 19, at sixty-five years of age, after suffering greatly from a complication of disorders. For the last two years he had shown signs of breaking down in health, partly owing to anxiety and the difficulty of getting and fulfilling a sufficient number of engagements to keep him fully employed. He leaves a widow and a family of four. About twenty years ago he was associated with such men as Huxley, Sir B. W. Richardson, and Lant Carpenter in the work of the Sunday Lecture Society, and he was well known at the leading literary and scientific institutions in London and the country as one of the most popular exponents of science. His pleasant and easy manner, with occasional gleams of Irish humour, made him welcome to his audiences. He was the author of many books and articles on the popular side of science, such as "The Hidden Beauties of Nature," "Nature, Curious and Beautiful," and "Wireless Telegraphy Popularly Explained." He had also two or three books ready for publication, but on account of the war he found it impossible to get them published. He was an artist of no mean merit, and drew the illustrations for his books and lantern-slides with his own hand. His ability was recognised by the Home Office, who employed him as a lecturer to H.M. Prisons.

It is proposed to found a memorial in honour of the late Mr. E. T. Busk, who met his death in November last at Aldershot while flying his own stable aeroplane, owing to its destruction by fire, thus terminating a career already marked by fine achievement and full of promise for the future. At Cambridge he took first class honours in the Mechanical Sciences Tripos, and was awarded the John Wimbourne prize and a scholarship at King's College. After passing some years as an engineer, he joined the staff of the Royal Aircraft Factory, where he devoted his time especially to the mathematics and dynamics of stable flight of the full-size aeroplane, to researches into the nature and cause of wind gusts, and to the uses of aircraft in warfare for offensive and defensive purposes. Besides this work, he was entrusted with the general control of the chemical, metallurgical, and physical research and test work at the factory. The memorial will consist of (1) a studentship to enable a student to carry on some research in aeronautics or a kindred subject, and (2) a lecture on some such subject to be given annually by the holder of the studentship or by some other lecturer, and to be published in the *Aëronautical Journal*. Subscriptions to the amount of about 250*l*. have been received or promised, and further contributions will be gratefully acknowledged by Sir Edward H. Busk, 11 Sussex Place, Regent's Park, N.W., or the secretary of the Aeronautical Society of Great Britain, 11 Adam Street, Adelphi, W.C.

According to a "neutral" correspondent of the *Times*, the Germans are busy with the preparation of smoke bombs to be dropped from Zeppelins when the long-talked-of air-raid on London takes places. We are told that an eye-witness saw the smoke cloud spread over an area of several kilometres! There is little difficulty in constructing a bomb which shall explode at a given distance above the ground and produce a dense cloud, but it is doubtful whether such a smoke cloud could be made to spread over anything like a distance of kilometres. We are told further that these bombs will prevent attack by anti-aircraft guns and aeroplanes. How it is to stop the latter, which travel at a much higher speed than a dirigible, and will certainly attack from above or at least on a level with the Zeppelin, is not clear. In the absence of any dissipating wind a Zeppelin free to choose her course may derive considerable advantage from a smoke bomb burst over a gun position, but some shots should certainly be fired before she has time to locate the gun, and then she must get well over the position to place the bomb effectively. Smoke is a very vague term, and whilst it may obscure physical vision may also be used to cover something far more dangerous. In this connection the warning issued by the Commissioner of Police to keep all windows and doors on the lower floors of houses closed, in the event of an air-raid, to prevent the access of deleterious gases is not without significance, and should certainly not pass unheeded.

The service of radio time signals which is now provided by the Union Government wireless telegraph stations at Cape Town (Slangkop) and Durban will be of inestimable value to shipping in South African waters. By means of such a service, vessels within range of the stations can ensure a precision of standard time which it would otherwise be impossible for them to obtain, and the new facilities should make for added safety in navigation. The Cape Town (call letters VNC) and Durban (VND) stations are open night and day, and work on a 600-metre normal wave. A special clock at the Cape Town Observatory is adapted to give automatically a series of signals extending over an interval of half a minute. The signals are transmitted at 11 p.m. Union time, which is equivalent to 9 p.m. Greenwich mean time, and shortly before that hour the clock is brought into conformity daily with the observatory standards. The time signal proper, which is preceded by the usual warning signal, consists of twelve dashes, each of about three-quarters of a second in duration, divided into five groups, the commencement of the separate dashes corresponding exactly with the following Greenwich mean times:—

Group I. h. m. s.	Group II. h. m. s.	Group III. h. m. s.	Group IV. h. m. s.	Group V. h. m. s.
8 59 30	8 59 38	8 59 44	8 59 48	8 59 54
8 59 32	8 59 40		8 59 50	8 59 56
8 59 34				8 59 58
				9 00 00

By means of a special relay the time signal is simultaneously transmitted to the Cape Town and Durban wireless stations, the signal to the latter station passing over the land telegraph wire connecting Cape Town and Durban, a distance of about 1100 miles. In addition to the time signals, both stations transmit each day, at 1 p.m., a report in plain language containing information concerning the meteorological conditions prevailing on the whole coast of the Union of South Africa.

The *Popular Science Monthly* for April contains a series of fifteen short articles dealing with American economic and social problems arising out of the war. Stress is laid primarily upon the necessity for the education of the American people in methods of maintaining health and prolonging life; it is shown that "degenerative diseases" are causing an increased death-rate which was nearly doubled between 1880 and 1910. The average man is not an able-bodied citizen; he is far below the attainable standard of physical soundness and efficiency. The war appears to cause the American to look more closely upon the value of a human life. A second point arises out of a consideration of the American mercantile marine. The merchant navy of the United States is totally inadequate to the carrying of more than one-tenth of the American trade. Americans are advised to seek for foreign trade with the same energy as they display in capturing markets in distant parts of the United States, and the Englishman is amused to learn that the American exporter is suspected of bad packing, lack of adaptability, and the dozen or so other faults which are alleged to be manifest among English exporters. Taken as a whole, the series is symptomatic of the stimulus which results from war; nothing can be quite the same again; distant America will share with the rest of the world in the changes, and notable Americans here display the tendency of their thoughts. The occasion for these articles was the meeting of the American Association for the Advancement of Science in December last.

The Zoological Society of Philadelphia is to be congratulated, since, according to its forty-third annual report, among a consignment of young bears, shipped from Europe as "Russian bears," two, a male and a female, prove on examination to be specimens of the rare blue bear of Tibet (*Ursus pruinosus*). The pathologist's report contains some valuable data on tuberculin tests, carried out on monkeys and birds, on enteritis among quails, and on larval and adult hook-worms, which were the cause of considerable mortality among the Canidæ during the year. Perhaps the most important parisitological item of the year was the discovery of cysts of *Coccidium bigeminum* in the fæces of a fox. This parasite has been found three times in man, and frequently in dogs, but it has never before been found in a wild animal.

Many items of more than usual interest are to be found in the Report of the South African Museum for 1914. In the first place, the director, Dr. Louis Péringuey, is able to state that the agitation, started some time ago in the Uitenhage district, for the destruction of the elephants in the Addo Bush, has not only failed, but that the Provincial Government is taking steps to ensure the safety of the three troops known to occupy the preserve. The herd apparently will have to be thinned, but no indiscriminate shooting will be allowed, and provision will be made for ensuring to the remainder a fair supply of water, the lack of which is oftener than not the cause of the animals' so-called depredations. The "wiping-out" of the herd, said to number 300 head, is no longer to be feared. Among the additions made to the collections during the year he directs special attention to "two extraordinarily large vessels affecting the shape of a hippopotamus" from southern Rhodesia. These bear a striking resemblance to the work characteristic of the early Egyptian civilisation, and afford a parallel to the large soap-stone bowls found at Zimbabwe by Bent, and the similar bowls used as fireplaces or ovens, found at Mercë and Abydos, close to the oldest known temples of Osiris.

A REPORT has recently been issued by the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland on the outbreak of the disease known as "furunculosis," which attacked the salmon in the river Liffey in 1913. The report (Fisheries, Ireland, Scientific Investigations, 1914, ii (1915), price 4*d*.) is by Prof. A. E. Mettam of the Royal Veterinary College, Dublin. After giving a useful summary of previous literature dealing with the disease, the author records the results of careful microscopical and bacteriological examination of a number of diseased fish. Attention was first prominently directed to the disease in Great Britain by outbreaks which occurred in 1911 in the Wye, the Exe, the Teign, and the Dart, large numbers of salmon, trout, and other fish being found dead in these rivers. The epidemic was reported on by Dr. A. T. Masterman, of the English Board of Fisheries. Prof. Mettam confirms the accounts given by previous workers. The diseased fish, which may or may not show external boils or lesions, are infected by a micro-organism (*Bacillus salmonicida*) which occurs in immense numbers in pus from the boils and also in the blood. Infection takes place very rapidly through the skin or gills, or from infected food. Healthy fish placed in infected water often succumb within a few days. It is suggested that a river may become infected by fresh-run salmon from the sea. All that can be suggested to check the disease in a river is the immediate removal and destruction of all dead and dying fish. Care should also be taken not to transfer fish or fish fry from an infected river to one which is free from the disease.

IN Bulletin No. 19, issued by the North of Scotland College of Agriculture, Prof. James Hendrick describes the composition and value of liquid manure as produced under the farming conditions of the north-east of Scotland. It is well known that practically the whole of the potash and readily available nitrogen is found in the urine, and where the litter is unable to absorb this completely, the surplus drains to the liquid manure tanks. The practical difficulties in the way of utilising liquid manure to the best advantage have in the past led to a waste of valuable fertilising material. Since potash manures are practically unobtainable at present, any method of preventing waste of this element has a special significance. During four seasons, 1910–13, liquid manure was applied to grass-land on farms in the district at various times from December to March. In all cases there was a considerable increase in the hay crop from the manured land. The average value of the increase, where 2000 gallons of liquid manure per acre was given, was 25*s*. per acre, with hay at 51*s*. per ton. The objections of the practical man that liquid manure applied in mid-winter would be washed from the soil before the plant could make use of it were not borne out by these experiments, which showed that the increase of crop from land manured in December was as great as where the manure was applied in March. The analyses of the various manures showed that where the liquid was applied at the rate of 2000 gallons per acre, the application was equivalent to artificials costing about 2*l*. per acre. The great part of this value was recovered in the grass during the season of application.

IN the Annals of the South African Museum, vol. ix, part iv., Prof. Pearson continues the enumeration of the plants collected in the Percy Sladen Memorial Expeditions of 1908–9 and 1910–11 in South-west Africa. The various natural orders have been worked out principally by Miss R. Glover and Mrs. Bolus. Of the new species described and figured, *Nenax Dregei*, L. Bolus (Rubiaceæ), *Anticharis juncea*, L. Bolus, a spinescent scrophulariaceous shrublet from Great Namaqualand, *Agathosma Sladeniana*, R. Glover (Rutaceæ), and *Lotonotis exstipulata*, L. Bolus (Leguminosæ), from the Cape region, are some of the most interesting. In the same number Mr. Phillips described three new species of Proteaceæ.

THE report of the director of the Botanic Gardens and Government Domains, Sydney, New South Wales, contains an interesting account of the work done in the Botanic Gardens in particular, and includes a number of excellent photographs of various parts of these justly famed gardens. Following the example of Kew we are glad to notice that a list of the fauna of the gardens is being compiled, and a large number of different species are recorded in this report.

MR. E. D. MERRILL describes four new species of Dillenia and twelve of Saurawia from the Philippine Islands in the *Philippine Journal of Science*, vol. ix., No. 6. Some forty species of the latter genus are now known from the islands. One of the Dillenias, *D. cauliflora*, though collected as long ago as 1838 by Cuming, has only now been determined with the help of new material from the Island of Samar. The Cauline inflorescence is a very unusual character in this genus.

IN the *Philippine Journal of Science*, vol. ix., No. 6, Mr. F. C. Gates gives an ecological account of the swamp vegetation in hot springs areas at Los Baños, Laguna. Hot-water bacteria and Cyanophyceæ were found in the hottest water sometimes more than 56° C., and in the surface water up to 52° C. filamentous blue-green algæ were found. Bacopa and Lippia fringed the pools, and the critical temperature for their growth proved to be from 48°–52° C. Other plants are noticed in connection with their relation to the springs and the swampy ground and the associations which they form.

Tropical Life for April, 1915, contains an interesting letter entitled "The Future of the Solomon Islands," in which an account of the islands is given, and their importance for the production of copra is described. The soil is very fertile, volcanic in origin, mixed with coral limestone, and with the rainfall averaging 90–200 ins., and a very humid climate, the coconut palm flourishes and bears very heavy crops. Some 25,000 acres are now under coconut plantations in the various islands. The palms come into bearing very early, and the writer of the letter records that he saw a tree under six years old bearing considerably more than 300 nuts, which is by no means a record for these islands. As the Solomon group lies on the direct route between Australia and the Philippines and Japan, the importance of the islands is likely to increase in the near future.

In the current number (vol. xiii., No. 1) of the Bulletin of the Imperial Institute attention is directed to the economic resources of the German colonies, and in particular to the agricultural and forest products of German East Africa. Copra, ground nuts, sesame seeds, oil palms, beeswax, cotton, coffee, grain, sugar-cane, and tobacco, all of which are in native hands, are among the products especially considered. The German East Africa Company also conducts a considerable sisal hemp industry—more than 367,000*l.* worth being exported in 1912—and there is extensive European cultivation of cotton, kapok, plantation rubber, and gutta-percha. The exports of the two latter products in 1912 reached the combined value of more than 362,000*l.* The bulk of the products went to Germany, but some of the rubber, coffee, copal, hides, and ivory have been coming to the United Kingdom.

The *Kew Bulletin* No. 3 contains papers dealing especially with questions of systematic botany, including descriptions of several new species. In notes on South African Santalaceæ Mr. Hill describes three new species of the singular little diœcious genus Thesidium. In some of the species the male and female plants are so dissimilar that unless found growing together, their relationship would not be recognised. A remarkable etymological invention originating with a misprint is pointed out in connection with the generic name Frisca, a synonym of Thesium, a misprint for *Th. Frisea*, a Linnean species of Thesium. Wettstein, in his "Etymologisch-botanisches Handwörterbuch," has "Frisca (Santalaceæ). Nach Th. Frisca, der sich am Cap im botanischen Interesse aufhielt." The mistake in spelling is due to Endlicher and Spach, but Wettstein is responsible for evolving from what is merely the name of a plant a person who in the interests of botany sojourned at the Cape.

Dr. C. F. Juritz, Government analyst, Cape Town, has recently visited the prickly pear station at Dulacca, Queensland, and contributed an interesting account of the prickly pear problem in Australia, which has been reprinted from the *Cape Times and Farmer's Record* for February 5. His account deals with the methods undertaken under the supervision of Dr. Jean White to eradicate the Opuntia and clear areas for cultivation. Of the two methods employed, the effects of chemicals and the introduction of cochineal, the former is likely to be more effective, since the insect has no effect on the most prevalent species, *O. inermis* and *O. aurantiaca*, which are protected by a layer of subcutaneous cells containing calcium oxalate. Of chemicals only those containing arsenic are of any practical value, and the effect of the gas arsenic trichloride appears to be very promising. The cost of destruction works out at about 15*s.* per acre. The use of the Opuntia as a source of potash and as a source of industrial alcohol promises some return on the outlay for destruction.

The *Cairo Scientific Journal* for September, 1914, contains an extremely interesting and valuable discussion of "The Frequency of Cloud-forms at Helwan, 1904–1913," by Mr. N. A. Comissopulos. Helwan is situated about eighty miles west of Suez and about 130 miles south-east of Alexandria. The discussion is suggestive in its method and arrangement, and well deserves to be imitated by other observers. The times of observation are 8 and 11 a.m., and 2, 5, and 8 p.m. each day, and the clouds have been tabulated and classified to determine their annual and diurnal variations. Cirrus clouds are shown to be the most frequent of all clouds; they attain their absolute maximum in May and their absolute minimum in July, whilst the cirro-stratus attains two maxima during the year, in December–January and in April, and the absolute minimum is attained in September. Other upper clouds are somewhat irregular. Intermediate clouds, as alto-cumulus and alto-stratus, were rarely seen. For lower clouds it is mentioned that the progress of nimbus is regular, the maximum occurs in January and the minimum in July; stratus has two distinct maxima, one in April and the other in October, with an absolute minimum in June and July. Fogs occur principally in the early morning and during the winter months. Forty-nine per cent. of all observations are clear skies, which shows the relative dry character of the Egyptian weather. The grouping of the clouds for the diurnal variation also gives fairly regular results.

The papers contributed to a general consideration of the hardening of metals, together with the discussion to which they gave rise at a recent meeting of the Faraday Society, of which an account was given in Nature of December 3, 1914 (vol. xciv., p. 374), have been reprinted as a brochure by the society with certain additions. The latter include communications from Arnold, Rosenhain, and Thompson. The pamphlet thus gives in a compact form an up-to-date summary of the principal current theories of hardening. After reading it, it is impossible not to be struck by the far-reaching influence of Beilby's theory of the vitreous-amorphous and crystalline conditions of metals and alloys in its bearing on this question, in spite of the statement of Arnold that "no modern theories have disturbed to any great extent the explanation of the hardening of steel made by Henry Clifton Sorby a lifetime ago."

The June and July, 1914, numbers of the *Journal de Physique*, which is now conducted by the French

Physical Society, have come recently to hand. In the former Prof. Lippmann describes a method of determining differences of longitude by taking instantaneous photographs of the stars at the two stations at the same moment. Prof. Bouty continues his examination of the fundamental assumptions of the kinetic theory of gases, and deals with the mean free path. M. J. Duclaux shows that the specific heats of a large number of organic liquids can be calculated directly from their chemical formulæ. The July number contains the lecture on photo-electricity given before the society in April, 1914, by Messrs. Pohl and Pringsheim. In addition to several shorter papers, the two numbers devote between fifty and sixty pages to abstracts of papers which have appeared elsewhere.

THE March issue of the *Presidency College Magazine,* Calcutta, contains a warmly appreciative article by Mr. F. V. Fernandes on the Indian School of Chemistry, with special reference to the work of Prafulla Chandra Rây and his pupils at the Presidency College. Prof. Rây is more particularly known to European chemists from his "History of Hindu Chemistry," and by his investigations on the inorganic and organic nitrites, a field of inquiry with which his laboratory has been specially identified, and with which certain of his pupils have been associated. Under the fostering influence of Principal James, Prof. Rây has gradually built up a distinct Indian School of Chemistry, and after centuries of scientific stagnation, India bids fair to recover something of her former position in the chemical world through the agency of the succession of pupils which have passed through his hands.

IN a recent number of the *Scientific American* (April 24, p. 379) a description appears of what is claimed to be the largest by-product coking plant in the world. Owing to the enormous natural fuel resources of the United States, economy in the use of fuel has received but scant attention. Future generations will have bitter cause for complaint about the prodigal waste of fuel by their ancestors; in no country more so than in that blessed with the greatest supplies. What this waste amounts to is now being realised, and in the production of metallurgical coke the lead of the Continent and Great Britain in the use of recovery plant is being followed. It is estimated that enough benzol to run 200,000 automobiles a year, and enough sulphate of ammonia to supply the farmers of the States with fertiliser for two years at the present rate of consumption, was thrown away in the waste gases of the beehive coke-ovens of the United States in 1912. Altogether the value of the by-products, had they been recovered, would have been about eighty million dollars. If the same amount of coal had been coked in retort ovens, more than five million more tons of coke would have been obtained. The new plant of the United States Steel Corporation comprises 560 ovens, and will produce 2,900,000 tons of coke annually. One hundred and twenty million cubic feet of gas will be obtained every twenty-four hours, half of which will be employed in heating the ovens, the other half for the corporation's steel furnaces. It is remarkable that this big plant is not equipped for the recovery of benzol. Owing to the native supplies of petrol, benzol as a motor fuel is not of that interest in the States which it is in Europe, especially at the present time; but even there benzol recovery will certainly soon become general, if only for the measure of independence it will secure against trusts and rings controlling the output of petroleum products.

"SANITATION IN WAR" is the title of a new book to be published about June 1 by Messrs. J. and A. Churchill, of 7 Great Marlborough-street, London, embodying lectures delivered by Major P. S. Lelean, assistant-professor of hygiene at the Royal Army Medical College. An introduction to the volume has been written by Surgeon-General Sir Alfred Keogh.

OUR ASTRONOMICAL COLUMN.

COMET TEMPEL 2.—A telegram from Prof. Strömgren, of Copenhagen, dated May 18, records the discovery of a comet by Delavan on May 16 at 20h. 52·2m. G.M.T. Its position is given as R.A. 0h. 33m. 1s., and declination $-2^{\circ}\ 5'\ 31''$ Its magnitude is not stated. From a communication to the *Morning Post* of May 20 the comet seems to be that of Tempel 2. It is there stated ". . . Tempel 2 has just been re-discovered by Delavan, who has been notably successful at La Plata in the last few years. The comet is probably not bright, and will very likely not be observed in this country, as it rises almost with the sun, and passed perihelion on April 14, only about one day from its predicted date. It is in a direction between the constellation of Pisces and Cetus. It was discovered by Tempel in 1873, and was observed in 1878, 1894, 1899, and 1904, so that three returns, including the last one, were not observed, its period being rather less than $5\frac{1}{4}$ years."

OBSERVATIONS OF SATURN AT FLAGSTAFF.—Writing to the *Astronomische Nachrichten,* No. 4800, under dates March 11 and 18, Prof. Percival Lowell says (March 11):—"The crepe ring of Saturn has been observed and measured persistently wider on the east than on the west side of the planet during the past month by a difference of five-hundredths. This fact will have important bearings on the mechanics of the stability of the ring. Any phase effect or defect of illumination of the constituents of the ring are not sufficient to explain the phenomenon on account of the diminutive size of the meteorites composing it. A possible explanation of this detected eccentricity of the ring may be the revolution of the perisaturnium." Writing on March 18, he says:—"Photographs of Saturn taken on March 12 at this observatory, both by Mr. E. C. Slipher and the director, confirm visual observations in revealing that Cassini's division is visible in part above the contour of the ball by about four-tenths of its true width. This enables the oblateness of Saturn to be deduced from the photographs, a preliminary reduction of which shows that oblateness to be about one-ninth."

THE SPECTRUM OF THE INNER CORONA.—In the *Ofversigt af Finska Vetenskaps-Societetens Förhandlingar* (Bd. lvii., Afd. A, No. 25) Dr. R. Furuhjelm communicates a note on the spectrum of the inner corona. The photographs were secured by an expedition from the observatory of Helsingfors, which took up its position at Kumlinge, isles of Aland in Finland, for the observation of the eclipse of August 14 of last year. Details of the instrument used are given, but it may be stated that the size of the image falling on the slit was 36·4 mm., and the spectroscope was furnished with three prisms of angles of about

63° each; the spectrum, extending from λ 456–λ 590, measured 38·7 mm. The author directs attention to the peculiar form of the green ray in one part, indicating, as he says, a relation between prominences and the corona. In the determination of the wave-length of the green ray he deduces a value 5303·38 ± 0·020, agreeing more closely with that of Campbell, namely, λ 5303·26, than that of Lockyer, λ 5303·7. For another line, behaving after the nature of the green ray, of which he determines the wave-length, he deduces the value λ 4566·81. Details of the researches he proposes to publish at a later date.

SPECTROSCOPIC ANALYSIS OF THE N'KANDHLA AND OTHER METEORIC IRONS.—Dr. J. Lunt describes in the *South African Journal of Science* (April, vol. xi., No. 7) a spectroscopic analysis which he has made of the N'Kandhla meteorite and of other meteoric irons. The spectra were photographed in the four-prism star spectroscope of the Victoria telescope of the Royal Observatory at the Cape, the spark being obtained between terminals of the meteoritic metal with an 18-in. coal and large plate condensers. The object of the research was to try to detect the presence of elements which might have escaped recognition in the previous chemical analysis, and to compare the composition of the N'Kandhla meteorite with that of four other meteoric irons, namely, the Great Namaqualand, Matatiele, Hex River, and Goamus. The result showed that cobalt, chromium, barium, and calcium were unmistakably present in the N'Kandhla, as well as in the other meteoric irons, though not detected chemically, and that no evidence was found of the presence of magnesium, platinum, and copper, traces of which were recorded in the chemical analysis. The non-metallic elements—carbon, sulphur, phosphorus, and chlorine—were recorded chemically, but furnished no spectroscopic evidence in the sparks, which were rich with the metallic elements. Dr. Lunt discusses in a series of paragraphs details with reference to the different elements found in these and other meteorites, and accompanies his paper with reproductions from strips of the spectrograms.

MEASURES OF SOUTHERN DOUBLE STARS.—The fourth series of measures of double stars is published by Mr. Innes in Circular No. 24 of the Union Observatory, the previous series having appeared in the Transvaal Observatory Circular, No. 13, and the Union Observatory Circulars, Nos. 4 and 14. The present series includes all pairs, more than 310 in number, for which satisfactory measures, equally divided between before and after meridian passage, have been made on at least two nights by the end of 1914. The telescope employed was the 9-in. Grubb refractor. A great many of the pairs were measured for the first time. The measures were for the most part made by Mr. Innes and Mr. Van der Spuy, but the latter left the observatory early in the year to join the Aviation Corps of the Defence Force, and afterwards was with the British Army in France.

MEASURING HEAT FROM STARS.—In this column for February 25 attention was directed to a paper by Dr. W. W. Coblentz on a comparison of stellar radiometers and radiometric measurements on 110 stars. In the May number of the *Popular Science Monthly*, under the title, "Measuring Heat from Stars," he describes in a very interesting manner early attempts at measuring stellar radiation, and the method employed by him at the present time. The article gives a good insight into the extreme delicacy of the investigation, the great progress that has been made in recent years, and the important outstanding problems which will no doubt be solved when the instrumental equipment has advanced a stage or two further.

RECENT WORK IN PALEONTOLOGY.

C. D. WALCOTT, among his studies entitled "Cambrian Geology and Palæontology," treats of a "a pre-Cambrian Algonkian algal flora" (Smithsonian Miscell. Coll., vol. lxiv., No. 2, 1914). The horizon is that which has yielded the famous crustacean remains known as *Beltina danai*. The author urges that the abstraction of carbon dioxide from water by the action of blue-green algæ and bacteria, such as *Bacterium calcis* of the Florida Keys, is a potent factor in the precipitation of oolitic and other forms of limestone, and he freely quotes recent work, such as that of E. J. Garwood, in support. He regards the dolomitisation of the older limestones that may have been formed in this way as a secondary feature (p. 96). The author's remarks, in answer to G. Abbott, contributed to NATURE of December 31, 1914, may imply some reconsideration of the part played by inorganic concretion in the structures here described as various species of Newlandia. Collenia (p. 98) becomes separated from Cryptozoön, the latter being regarded as appearing for the first time in the Cambrian period.

G. R. Wieland has meanwhile published further studies on Ozarkian seaweeds and oolites (Bull. Amer. Mus. Nat. Hist., vol. xxiii., 1914, p. 237), dealing especially with Cryptozoön. He connects these Cambrian forms with the far smaller Girvanella, as a "homogeneous assemblage" of sea-weeds, and enters into a somewhat confusing argument as to whether their silicification occurred early or late in geological history. This leads on to a discussion of the associated beds of siliceous oolite, which are held to be primary deposits, and especially characteristic of early Palæozoic times (p. 255). The Jurassic oolites preserved in flint at Portland, and the siliceous residues of the oolitic grains of ferrous carbonate in the pseudomorphous ironstones of Cleveland, are English evidences against this contention. Both Wieland (p. 248) and Walcott threaten us with a re-opening of the Eozoön question on algal lines, despite the work of Gregory and Johnston-Lavis on the limestone blocks of Monte Somma and several publications on layer-structures from the osmotic point of view.

G. R. Wieland is associated with Marion G. Elkins in a paper on "Cordaitean wood from the Indiana Black Shale" (*Amer. Journ. Sci.*, vol. xxxviii., 1914, p. 65). The horizon is Upper Devonian, and the wood of the new species, *Callixylon oweni*, is exceptionally well preserved. From the great variety of structure in Devonian woods and the diversity of the ancient seed-types, the authors conclude that "if there is any past period which can be fairly singled out as the true age of gymnosperms it must be Devonian time."

H. Hamshaw Thomas has begun a systematic examination of the Middle Jurassic flora of Cleveland in Yorkshire, in which cycads are prominent (*Quart. Journal Geol. Soc.*, London, vol. lxix., p. 223). Wieland's review of "the Williamsonian tribe," in which British specimens from the Yates collection are utilised, will no doubt be referred to as the work goes on (*Amer. Journ. Sci.*, vol. xxxii., p. 433). Both authors point out how we are indebted to Nathorst for additions to our knowledge of the cycad fruits of Yorkshire. F. H. Knowlton compares the Jurassic flora of Cape Lisburne, Alaska (U.S. Geol. Survey, Prof. Paper, 85-D, 1914), with that described by Heer and Seward from Amurland in eastern Siberia, and takes the opportunity for a brief review of the Arctic and Antarctic occurrences on the same horizon. The Alaskan beds (p. 43) are "probably not older than the Bathonian and certainly not younger than the Oxfordian."

E. Wilbur Berry (*ibid.*, 84, 1914) issues a report on the Upper Cretaceous and Eocene floras of South Carolina and Georgia. Ficus is represented in the Cretaceous beds of South Carolina by five species, and the willow, the oak, the myrtle, and the laurel are among the numerous angiosperms present. The author (p. 71) regards this flora, the post-Raritan floras of the eastern States, and the major part, at least, of the Dakota flora, as Turonian and not Cenomanian in age. The Cretaceous flora of Georgia (p. 127) is placed on the same horizon. A small Middle Eocene (Claiborne) flora of seventeen species allows of an interesting discussion of Cainozoic climate in the eastern States. The main features of the modern flora of tropical America extended as far north as latitude 33° in Middle Eocene times, and retreated later towards the West Indies. In the same paragraph on p. 161, this retreat seems to be dated as "toward the close of the Tertiary," and also, on Dall's evidence from marine life, as "at the close of the Oligocene." The bibliography is useful to all workers in early Cainozoic floras, including that of Bovey Tracey in Devonshire.

David White (*ibid.*, 85-E, 1914) emphasises the occurrence of thread-like resinous casts in "mother of coal" and other Palæozoic "coals of high rank," associated in places with megascopic lumps of resin. By the decay of the plant tissues (p. 82), these resinous infillings of secretory canals have become concentrated in undue proportion in the coals.

A paper by F. W. Clarke and W. C. Wheeler (*ibid.*, 90-D, 1914) has a bearing on the occurrence of magnesium carbonate in rocks. It discusses "The Composition of Crinoid Skeletons," and twenty-one species, representing as many genera, are shown to utilise in their hard parts from 7·28 to 12·69 per cent. of magnesium carbonate, when organic matter is eliminated from the analyses. A specimen of *Hathrometra dentata* includes, moreover, 5·73 per cent. of silica, a substance usually present in quantities of about 0·1 per cent. When arranged by localities, it is seen "that the proportion of magnesium carbonate in crinoids is in some way dependent on temperature" (p. 36). Shallow water in the tropics gives the highest percentage. The calcium carbonate is always in the calcite state. The investigation of fossil crinoids, from the Lower Ordovician to the Eocene, shows nothing higher than 2·56 per cent. of magnesium carbonate, except in a Triassic form, *Encrinus liliiformis*, which yields 20·23 per cent. We may conclude that the matrix was in this case dolomitic. It is suggested that infiltration of calcium carbonate has reduced the proportion of magnesium carbonate present in fossil specimens. The organic matter in recent forms, often amounting to 15 per cent., would certainly allow of the substitution of some other material during fossilisation.

Ivor Thomas's first section of his revision of "The British Carboniferous Producti" (Mem. Geol. Survey of Great Britain, Palæontology, vol. i., part 4, 1914) covers the genera Pustula and Overtonia, which are here established (p. 259) on *Productus pustulosus* and *fimbriatus* respectively. But the special importance of the memoir lies in the review of the Producti generally, based on the work of several years. Doubt is thrown (p. 229) on the clasping nature of the spines of Productus, and it is suggested that a spine during growth may occasionally be diverted by an adjacent object, so as to appear to fold around it. Both external and internal features of the shells are discussed in relation to the animal as it lived, and no apology is needed for the consideration of the general principles of mutation and the meaning of species, questions that have naturally forced themselves before the philosophic author.

It is interesting to note, in L. W. Stephenson's study of the "Species of Exogyra from the Eastern Gulf Region and the Carolines" (U.S. Geol. Survey, Prof. Paper 81, 1914) that the genus was first described by T. Say in 1820, the type being *Exogyra costata* from the Cretaceous of New Jersey. The "Sby." after the name in Woodward's "Manual of the Mollusca," 1851, is probably a mere misprint. *E. costata* is shown regularly to succeed *E. ponderosa*, the species having thus a zonal value. The strata are described in the same memoir.

In vol. xlii. of the Records of the Geological Survey of India (1912, p. 1), R. Bullen Newton and E. A. Smith have directed attention to the survival of a well-known Miocene oyster, *Ostrea gryphoides* (=*crassissima*), in recent marine deposits under Calcutta and in the Bay of Bengal.

Passing to arthropods, C. D. Walcott gives us a new genus of trilobites, Saukia, with numerous species, separated from Dikellocephalus by the possession of a longer glabella and pygidium ("Dikelocephalus and other Genera of the Dikelocephalinæ," Smithsonian Miscell. Coll., vol. lvii., 1914, p. 345). On p. 363 the author explains the common retention of D. D. Owen's spelling of Dikellocephalus with a single "l," under a rule that was surely established by persons with limited glabellas. Osceolia and Calvinella are here founded on *D. osceola* and *D. spiniger* (p. 388) respectively, though on p. 365, probably by a slip, the latter species is referred to Saukia. It seems from p. 364 that Walcott is unwilling to recognise Dikellocephalus from any locality outside the United States, and this should lead to a new examination of British and other European forms. The Devonian faunas of South Africa and South America receive a new link in the discovery by S. J. Shand of a species of the Brazilian trilobite Pennaia in the Bokkeveld Beds of the Hex River in the Cape Province (Trans. Geol. Soc., S. Africa, vol. xvii., 1914, p. 26).

Alexander Petrunkevitch has produced "A Monograph of the Terrestrial Palæozoic Arachnida of North America" (Trans. Connecticut Acad. Arts and Sciences, Yale University Press, 1913). This is a systematic review, not quite so extensive as its title would imply, of the American Palæozoic types of scorpions and spiders, involving the establishment of new genera and species. The author directs attention (p. 20) to the recent work of Clarke and Ruedemann, which indicates a relationship of the eurypterids with the succeeding limuloids, rather than with the scorpions, although the three groups may have had separate ancestors. The Carboniferous arachnid faunas of Europe and North America are stated to be distinct (p. 26); but both have a more tropical character than is found locally in their modern representatives. The excellent photographic plates are from specimens developed with much care by the delicate chiselling away of flakes of rock in order to reveal appendages.

R. Broom records (Bull. Amer. Mus. Nat. Hist., vol. xxxii., 1913, p. 563) his studies of a number of Permian labyrinthodont skulls in the American Museum, in which he has succeeded in tracing sutures hitherto obscure, and thus in providing new descriptions of the cranial elements.

R. S. Lull describes (*Amer. Journ. Sci.*, vol. xxxvii., 1914, p. 209) a "Fossil Dolphin from California," which is presumed to be of Miocene age. The specimen is placed under the living genus Delphinus, which is thus added to the few mammalian genera that have come down to us unmodified from older Cainozoic times.

A wide interest is attached to the investigation of the "Paleocene Deposits of the San Juan Basin, New Mexico," by W. J. Sinclair and W. Granger (Bull. Amer. Mus. Nat. Hist., vol. xxiii., 1914, p. 297), since these beds contain the oldest known Cainozoic mammals. The famous Puerco clays rest unconformably on a conglomerate with silicified tree-stems, below which are shales containing deinosaurs. No deinosaurs have been found in the Puerco Beds, and the faunal change is even here remarkably abrupt. Fossil plants, of no stratigraphical import, have been found for the first time (p. 306) in the Puerco Beds.

Among faunistic papers, we may note that the indefatigable C. D. Walcott reviews, with a bibliography, the "Cambrian Faunas of Eastern Asia" (Smithson. Miscell. Coll., vol. lxiv., 1914, p. 1).

G. A. J. C.

THE PLACE OF LAVOISIER IN THE HISTORY OF CHEMISTRY.

A SOMEWHAT novel view of "The Place of Lavoisier in the History of Chemistry" is put forward in a paper contributed by A. Mieli to the April number of *Scientia*. This question has formed the subject of prolonged controversy, and has called forth the most diverse and contrary opinions. Some, with Wurtz, have boldly acclaimed the fact that "Chemistry is a French science. Its founder is Lavoisier, of immortal memory." Others have written him down as a mere plagiarist, who purloined from Priestley the discovery of oxygen, and from Cavendish the discovery of the composition of water, and thus built up a great reputation on the unacknowledged work of his English colleagues. The Italian writer asserts that these claims and counterclaims are based upon a misconception. Lavoisier's true place is not at the beginning of the period to which the atomic and molecular theories belong, but at the close of an earlier period in which the chief problems were the nature of combustion, and the composition of air and water. This period opens with Jean Rey and Boyle; John Mayow had practically reached a true solution of the main problems in 1674; but Becher and Stahl intervened, and it was only by the work of Black, Priestley, Cavendish, and Lavoisier that all difficulties and doubts were finally cleared away. Lavoisier's position in the historical sequence enabled him to use all the information and experience that had been gathered during the preceding 150 years, and it was right that he should do so, though his acknowledgments to Priestley and to Cavendish might well have been more generous.

But whilst Lavoisier contributed a brilliant finale to the earlier period, his work cannot be regarded as forming in any sense an overture to the period which followed. The chief topics to be studied in the later period were those which were concerned with atoms, molecules, and equivalents. This period began with Dalton's atomic theory and the controversy between Proust and Berthollet on the subject of fixed or variable proportions; Avogadro (like Mayow) almost solved the problem; but once again a long interval of doubt and confusion ensued, until at last the work of Dumas, Laurent, and Gerhardt, and, above all, St. Claire Deville's discovery of dissociation, enabled Cannizzaro to put forward the masterly exposition which finally dispelled the uncertainty and perplexity which had afflicted chemistry for nearly forty years.

Cannizzaro, like Lavoisier, owed much to others. His experimental work was on a much smaller scale than Lavoisier's; but he is universally honoured as the man who cleared away the obstacles that had hindered the progress of knowledge during many weary years. Lavoisier's chief claim to immortality is of a similar character. It rests upon the fact that he was able to break through the entrenched lines of the "phlogiston" theory, and to make a broad gap through which others could enter the open plain beyond. His tragic death prevented him from reaping the full fruits of his victory over error, and it was left to others to undertake the conquest of the fertile country into which he had opened the way.

The periods suggested by the author are described in a paper communicated to the Italian Chemical Society (*Rendiconti Soc. Chim. Ital.*, 1914, vol. viii.) as follows:—

(1) The Philosophic Period, 600 to 300 B.C., including the writings of Empedocles, Aristotle, and others. (2) The Ancient Alchemistic Period, extending to about 1000 A.D., and dominated by the writings of Geber. (3) The Alchemistic Period of the Middle Ages, extending to about 1400 A.D., and including such names as Avicenna, Roger Bacon, Raymond Lully, Albertus Magnus, and the pseudo-Geber. (4) The Period of the Renaissance, including the work of Agricola (1494–1555), Bernard Palissy, and Paracelsus (1493–1541). (5) The Iatro-Chemical Period, originating with Paracelsus, and culminating in the work of van Helmont (1577–1644). (6) The Pneumatic Period, beginning with Boyle, including Stahl, Black, Cavendish, Priestley, and Scheele, and brought to its conclusion by Lavoisier. (7) The Period of the Modern Atomic Theory, beginning with Dalton, carried forward by Gay Lussac, Avogadro, Ampère, Davy, and Berzelius, and brought to completion by the exposition of Cannizzaro. (8) The Period of Organic Chemistry and of the Periodic Law, including Liebig, Wöhler, and Dumas, on the one side, Mendeléeff and Lothar Meyer on the other. (9) The Period of Physical Chemistry, originating with van't Hoff and Arrhenius. (10) The period of Radio-activity.

T. M. L.

FISHERY RESEARCH IN INDIA.[1]

MR. SOUTHWELL deserves the thanks of those interested in the better organisation of Imperial resources for summarising the history of fisheries research in India. That dates back only to 1906, for the work of Dr. Francis Day and Colonel Alcock was purely systematic. In 1906 economic research was initiated. Sir K. Gupta, then about to retire from the higher ranks of the Indian Civil Service, was ordered to inquire into the fisheries of Bengal. This officer tells us himself that he "knew nothing of fish," and that he "had not even done anything with the rod and line." Nevertheless, he made a lengthy tour in Europe and America to see those who did know, and on his return to India a Bengal Fisheries Department was established, with Mr. A. Ahmed as Commissioner.

The Department then obtained the services, for a year or so, of Dr. J. T. Jenkins, and an English steam trawler, the *Golden Crown*, was sent out to make a survey of the fishing grounds in the Bay of Bengal. While this was going on Mr. Ahmed established a Board which met five times, after which he "ceased to be Commissioner." The result of a very imperfect survey was the formation of a Fishery Department consisting of two directors of agriculture ("whose knowledge of the fisheries is necessarily of an entirely administrative nature"), of Mr. Southwell himself (a trained zoologist), as deputy-director, and

[1] Report on Fishery Investigations in Bengal, etc., with Recommendations for Future Work. By T. Southwell, Deputy Director of Fisheries for Bengal, etc. Bulletin No. 5. Department of Fisheries, Bengal. (Calcutta: The Bengal Secretariat Book Depot, 1915.) Price 6*d*.

of two superintendents of fisheries. One of these latter officials graduated at Calcutta University as M.A. in light and acoustics, and afterwards carried on physical research, and the other was a student at the same University, but "failed to take his B.A. degree." The Department is allowed the use of a laboratory at the Indian Museum, and has also a laboratory on board a steam launch. Thus staffed and equipped it is proceeding with the investigation of Bengal fisheries!

The latter are fresh-water, estuarine, and marine. The edible fresh-water fishes are mainly various species of carp, and a Clupeoid fish called the hilsa. The carps breed in the rivers during the rains, and since extensive areas of Bengal are then flooded enormous numbers of fry are lost in the paddy-fields. How to make good this loss by artificial culture, and also how to deal similarly with the hilsa are obvious problems, neither of which was solved by Dr. Jenkins or Mr. Southwell. The estuarine fisheries are located in the Sunderbans—that is, the rivers, swamps, and islands formed by the deltas of the Ganges and Brahmaputra. Here there are abundant edible fishes and crustacea, but no edible mollusca. The fishing grounds are far away from the traffic routes, and the fishing boats and gear are crude and inefficient. The fauna of the Sunderbans is not even adequately investigated. Dr. Jenkins spent thirty days there with an imperfectly equipped steam launch. Mr. Southwell tells us that Dr. Jenkins showed that "the fish fauna varied greatly according to degree of salinity, depth of water, etc., and observed that nets suitable for fishing in one part of the estuaries might be unsuitable in other parts"—results that might have been predicted! He also concluded that a "properly organised scheme of development of these fisheries would yield a profitable return on capital invested"—an equally indisputable conclusion!

Much more is known about the prospects of a marine fishery. Colonel Alcock regarded the fishery of the Bay of Bengal as of very great potential value. There are numerous species of edible fishes, mostly Siluroids, Scienoids, Serranoids, Pleuronectids, and Clupeoids. Dr. Jenkins and Dr. Annandale, of the Indian Museum, have made good reports on the collections made by the former. The *Golden Crown* was an inefficient and poorly equipped steam trawler, and was, moreover, hampered in its work by the Commissioner of Fisheries, but Dr. Jenkins showed that it was possible to trawl in the Bay of Bengal throughout the whole year. The vessel caught, on the average, 26·6 cwt. of fish a day. (The average catch per day's absence from port of an English steam trawler varies from about 60 cwt. to about 9 cwt., according to the fishing ground. The average catch per day for the North Sea, before the war, was about 17 cwt.) If it were possible to eat, with pleasure, all the species of fish caught, the *Golden Crown* therefore had good results. Dr. Jenkins showed also that it was possible to send fish in good condition to the Calcutta markets, and that the difficulty of navigation of the Hooghly could be evaded. There was reason for believing that European fishery methods would succeed in the Bay of Bengal.

But so far they have not been attempted, nor has the development of the fresh-water and estuarine fisheries been seriously attempted. One's impression in reading the report is that of a Department which, having the conviction that something ought to be done, yet contents itself by doing it badly. Commercial exploitation is, of course, a matter for private enterprise, but it is "up to" the Department which has modelled itself on European lines to see that scientific research is adequately promoted. J. J.

VENTILATION AND HEALTH.

A NEW YORK State Commission on Ventilation has been established by the New York Association for Improving the Condition of the Poor, with the help of a grant from Mrs. E. M. Anderson. The Commission consists of the university professors respectively of physiology, chemistry, psychology, and clinical medicine, together with a ventilating engineer and an officer of the New York State Department of Health, all of whom give their time voluntarily. A Commission so constituted ought to produce results of great value. An experimental chamber has been put up and equipped with all necessary apparatus, and researches have been made into the conditions of schools, hospitals, business houses, etc. The Commission has now issued its first report. The report confirms the view that the physical, rather than the chemical, conditions of the air are of the greater importance. That temperature, humidity, and movement ot the air and its freedom from dust, bacteria, and odour are the first essentials of ventilation.

Stagnant air at the same temperature as fresh air, even when it contains twenty or more parts of carbon dioxide, and all the organic and other substances in the breathed air of occupied rooms, has, so far, shown no effect on any of the physiological processes, except that the appetite for food may be slightly reduced.

Here we have confirmation of the view recently expressed in these columns by Prof. Leonard Hill, that stagnant air by reducing the metabolism of the body impoverishes the health and vigour of the body. Over-heated rooms produce a slight but distinct elevation of body temperature, increase the rate of the heart in the reclining posture, and its acceleration on rising from the reclining to the standing posture, and slightly lower the systolic blood pressure. The increased heart rate and diminished blood pressure found in the standing position show how the heated atmosphere relaxes the tone of the body, and tends to make the blood sink down into the dependent parts, and so produces sensations of fatigue, and reduces the inclination to work. The physiologist of the Commission, Prof. Fred S. Lee, determined after exposing cats to over-heated rooms that their excised muscles were more easily fatigued than those of the controls—14–26 per cent. less work was done. The sugar in their blood was also diminished.

In a commercial establishment employing about 4000 clerks, it was found that the building was grossly overheated. The fault lay in large part with the disrepair into which the thermostats had been allowed to fall. In certain ducts designed for fan ventilation no fans had been installed, while in others the fans were running at only a fraction of their efficient speed. In other ducts the register openings were so badly adjusted that while some rooms received more air than needed, others received less.

In one hospital in New York notorious for its overheating, records of 70°, 74°, and two 75° and above were obtained. In the children's wards five out of eleven records were more than 70° F. In one hospital the children's ward was 76° in the daytime. The Commissioner regards anything below 70° F. as free from over-heating!

Abominable conditions are proven then in certain institutions in New York, conditions which sap the health and vigour of the young, and turn them, so to speak, into weak hothouse plants. General recognition is required that the chief aim of ventilation is to provide a moving current of cool air, to remove the heat produced by human metabolism, and by the combustion of illuminants. The Commission, so far, has added a considerable amount of useful information and evidence confirmatory of the views held by physiologists in this country.

The Commission points out how in the case of a school building the chosen architect strives to outdo the others in the size and ornamentation of the building, and to satisfy the excessive requirements of the school committee. Then begins the process of trimming, and the heating and ventilating plant being the biggest single item of equipment, comes in for the most attention, with the worst results. And this, too, despite the fact that the ventilating plant is really the lungs of the building, and counts most for the comfort and efficiency of the occupants. "But, of course, there must be so many rooms, just so many gargoyles, and just so much marble. For these things are seen and read of all men."

THE UTILISATION OF SOLAR ENERGY.[1]

IN the first part of the paper referred to below are given particulars of the various apparatus which have been used to obtain power from solar radiation. In doing so the author was able to describe in fair detail the construction of such apparatus, but he stated that he had been unable to get any but the most meagre information as to the results obtained with the various plants, and much of that appeared to be untrustworthy. The case was very different in regard to Shuman's work since and including the year 1910, for the author himself had conducted the experiments with Shuman's plants.

Shuman set out with the idea that the principle of former workers in this field of using high-pressure steam was wrong. He argued that high-pressure steam meant a high temperature, and therefore a large loss due to radiation. We shall see later that though this is true, a better overall efficiency is attained when the steam pressure is higher and the boiler area is reduced, so as to save loss due to radiation. It is also a thermal advantage to have a high concentration of the solar radiation, but Shuman started first of all without any concentration (which has its advantages by reason of simplification); then he used a concentration of two to one, and finally 4·6 to one.

As steam was to be generated at a low (say atmospheric) pressure, an efficient engine for the use of such steam had to be designed, and in this Shuman was uniquely successful, for when the author tested a Shuman low-pressure engine at Erith he found that its steam consumption was only 22 lb. of steam at 16·2 lb. sq. in. abs. per b.h.p. hour, the b.h.p. being 94·5. This beats all the old atmospheric engines, and indeed everything to date for steam at that pressure.

Shuman's 1910 sun heat absorber had an area of only 15 sq. ft., and the tests made with it showed that at its best 300 sq. ft. of it would be required to produce enough steam for one b.h.p., allowing the aforementioned 22 lb. per b.h.p. hour.

In 1911 Shuman made another absorber like that of 1910, except that it had two plane silvered glass mirrors, one attached to the upper edge of the "hot-box" and one to the lower, and so arranged that 2 sq. ft. of solar radiation were concentrated on to 1 sq. ft. of boiler surface. The hot-box (originated by H. B. de Saussure, the Swiss geologist, physicist, and naturalist, who died in 1799) was 3 ft. wide, 6 in. deep, and 66 ft. long. There were twenty-six such sections. The back was formed of ⅜-in. millboard, on top of which was 2 in. of cork-dust, covered with ¼-in. millboard. The laminar boiler (about ¼ in. thick) was fixed in front of this, leaving an air space of an inch between it and the millboard. In front of the boiler was another air space of an inch, then a sheet of window-glass, another air space of 1 in., and finally the top sheet of window-glass. 10,296 sq. ft. of solar radiation were thus collected, and the best hour's run gave 816 lb. of steam at a pressure of 14·2 lb. sq. in. abs., equivalent to 26·8 b.h.p. and a thermal efficiency (of the absorber alone) of 29·5 per cent.

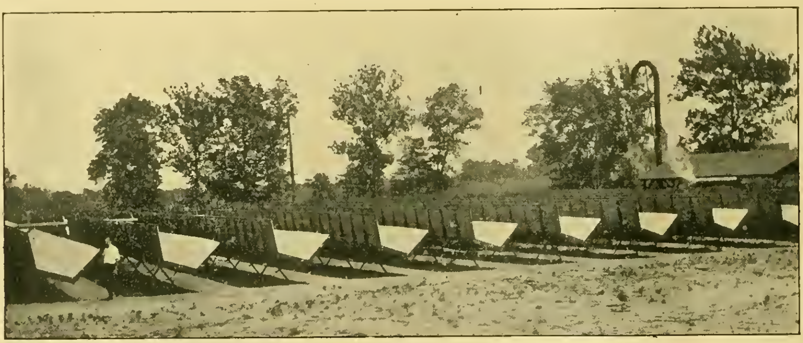

FIG. 1.—General view from the west of the Shuman absorber, Tacony, 1911.

The orientation of these reflectors was east and west, and they did not "follow the sun," consequently the output of steam fell off considerably in the morning and evening. The solar radiation was received on only *one* side of the 1911 boiler, while the other side lost some of it, but, due to Prof. C. V. Boys, F.R.S., the boiler which the author tested in Egypt in 1913 received heat on both of its sides, and its top edge as well, and the concentration was 4·6 to 1. The orientation of the reflectors was north and south, and they were made automatically to "follow the sun." Each reflector was trough-shaped, parabolic in cross section, 13 ft. 5 in. across the top and 205 ft. long, and there were five such sections. Hence 13,752 sq. ft. of solar radiation were collected. The

[1] Abstract of a paper read before the Royal Society of Arts on April 28 by A. S. E. Ackermann.

cast-iron boilers had a perimeter of 2 ft. 11 in., and were 205 ft. long. They were tested both naked and covered, the covering being formed of one layer of window-glass, butt jointed, and the best results were obtained when they were so covered. The best run of an hour gave 1,442 lb. of steam at a pressure of 15·8 lb. sq. in. abs., equivalent to 55·5 b.h.p. = 63 b.h.p. per acre of land occupied by the plant; while the *average* power for the five hours' run on that day (August 22, 1913) was 59·4 b.h.p. per acre, and the minimum on the same day was 52·4 b.h.p. per acre, a decrease of only 16·8 per cent. The maximum thermal efficiency of the absorber alone was 40·1 per cent., or 36 per cent. better than the thermal efficiency of the 1911 absorber, while its steam production was $33\frac{1}{3}$ per cent. better.

The author's experiments in Egypt show that a *decrease* of 20 per cent. in the humidity of the atmosphere caused an *increase* of 30 per cent. in the steam production.

Nearly all the technical part of the paper is contained in three appendixes, while a fourth consists of the bibliography of the subject.

In appendix i. it is shown that when the 1913 absorber was tested with naked boilers, the solar heat not used, and expressed in B.T.U. per hour per sq. ft. of boiler surface per 1° F. difference in temperature between the boiler and the air, is nearly constant and equal to 8·68.

In appendix ii. is derived the equation to thermal efficiency of a solar heat absorber and the efficiencies calculated by means of it are compared with the actual thermal efficiencies.

In appendix iii. the equation to the thermal efficiency of the absorber is combined with the equation to the thermal efficiency of a Carnot engine, thus giving the overall thermal efficiency. From this it is shown that the theoretical maximum overall efficiency of the 1913 Egyptian plant was 5·9 per cent., while the actual efficiency was 4·32 per cent. Thus 73·2 per cent. of the maximum possible efficiency was attained.

The equation to the thermal efficiency of the absorber is :—

$$\eta = \frac{Dsa - pk(T^4 - \frac{2}{3}A^4) - (1-r)Dsa}{Dsa} \quad . \quad . \quad . \quad (1)$$

and to the overall efficiency it is :—

$$\eta_0 = \frac{\{Dsa - pk(T^4 - \frac{2}{3}A^4) - (1r)Dsa\}(T - 568)}{Dsa} \quad . \quad (2)$$

The coefficient $\frac{2}{3}$ appears with the A^4, because the mirrors encircled only $\frac{2}{3}$ of the perimeter of the boiler.

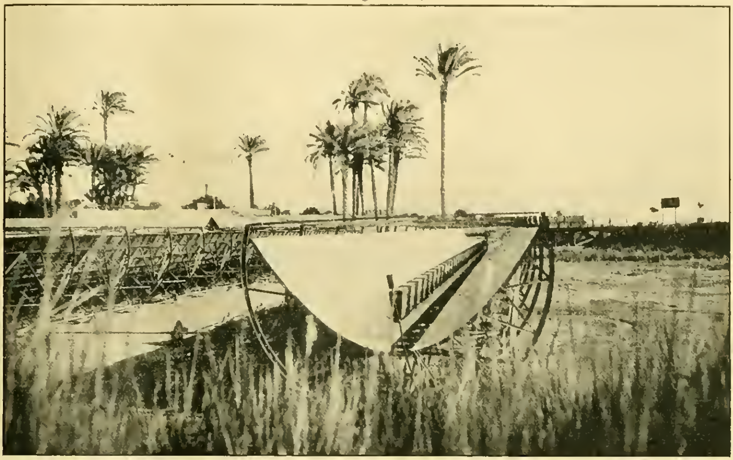

FIG. 2.—Shuman-Boys absorber, Meadi, 1913. One section of the absorber from the north.

Inserting the values of the known quantities for the Egyptian plant gives :—

$$\eta_0 = 0{\cdot}71 - 404T^{-1} + 9{\cdot}45 \times 10^{-10}T^3 - 1{\cdot}664 \times 10^{-12}T^4 \quad (3)$$

where D = the width in feet of the reflector; p = the perimeter in feet of the boiler; r = the efficiency of silvered glass as a reflector of heat; s = the solar constant in B.T.U. per square foot per min. = 7·12; a = the coefficient of atmospheric transmission; T = the absolute temperature in degrees F. of the boiler; A = the absolute temperature in degrees F. of the reflectors; 568 = the absolute temperature in degrees F. of the condenser; k = the coefficient of radiation, conduction, and convection = $10^{-10} \times 0{\cdot}36$ B.T.U. per sq. ft. per min., this value having been determined by the author in 1899 under almost the same conditions as those to which it is now applied.

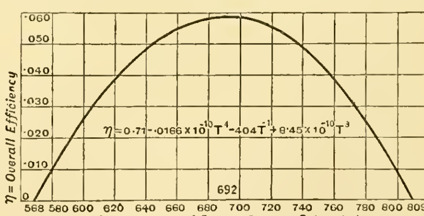

FIG. 3.—Curve showing the relation of the overall efficiency of the 1913 Shuman-Boys sun-heat absorber (with naked boiler), combined with a Carnot engine, to the absolute temperature of the boiler steam.

The graph of equation (3) is given in Fig. 3, from which it is seen that for a naked boiler, *i.e.* one without a glass cover, the maximum overall efficiency obtains when T=692° F. corresponding with a steam pressure of 21 lb. sq. in. abs. Or, of course, if equation (3) be differentiated with regard to T, and the result equated to 0, we also obtain T=692° F., from which is obtained the maximum value of η_0.

THE RIGID DYNAMICS OF CIRCLING FLIGHT.[1]

ONE of the main objects of the investigation described in this paper is to ascertain the conditions which render it easiest to steer an aeroplane in a horizontal circle of any radius that is not too small, and the idea of "inherent controllability" has been introduced to denote the property which a system may possess of freely describing a circular path without any pressure on the controlling rudders. In such cases the rudders will act as guides by preventing the aeroplane from leaving the chosen path, and as the system without them must, from the nature of the case, be wanting in directional (lateral) stability it is necessary for the working of such a system that the addition of the rudders should render it stable. The conditions for this must be worked out by the methods described in the lecturer's book, "Stability in Aviation."

It will be found that there are several different ways of obtaining inherent controllability and that in circling flight the system turns about a point which in some cases is in front and in some cases behind the centre of gravity. The axis of x or horizontal line through the centre of gravity in the direction of forward motion thus envelopes a circle of radius, a, the "turning point" being the point of contact of the axis tangent with its envelope, and the lateral or sideways velocity of the aeroplane being proportional to the distance of the centre of gravity from the turning point. This length and the inclination of the aeroplane to the vertical constitute two independent variables which can be so chosen as to satisfy two conditions of lateral equilibrium, but as there are three, a third variable is in general required, and if a rudder plane is used, this latter variable may be taken to be the pressure on that plane. The condition for inherent controllability is that the three equations of lateral equilibrium should satisfy some further identical relation by which the number of variables is reduced to two, and there are several ways in which this may be done.

The results here summarised lead to some interesting conclusions which were quite unexpected when the paper was commenced. In particular, they show the differences in behaviour between wings that are bent up and down respectively, the advantages, in certain circumstances, of curved wings as contrasted with plane wings bent into a simple dihedral angle, and generally that the form and curvature of the wing areas may play a much more important part in circling flight than had been anticipated.

The applications to the flight of birds are obvious, and suggest much interesting material for discussion. At any rate, a good many peculiarities in the wing structure of the circling birds appear to admit of interpretation on dynamical principles.

With regard to the possible application of these results to actual areoplanes, it remains to be seen how far it is desirable or practicable to realise the conditions of inherent controllability in a real flying machine. But the lecturer suggested that a study of the present work, followed by a few experiments, will either lead to improvements in the steering of aeroplanes, or if the present arrangements are the best, it will now be easier to understand the reason why.

[1] Abstract of the third Wilbur Wright Memorial Lecture delivered before the Aeronautical Society on May 20, by Prof. G. H. Bryan, F.R.S.

Summary and Conclusions.

(1) In steady motion in a horizontal circle, both the longitudinal and the lateral equations of equilibrium are affected.

(2) The turning point may be in front of or behind the centre of gravity, its distance when in front being denoted here by b.

The axis of the aeroplane then envelopes a circle of a certain radius a, the real radius of the circle described being $\sqrt{(a^2+b^2)}$.

The system usually cants over sideways through a certain agle ϕ.

(3) Given the velocity and radius of the circle it is not usually possible to satisfy the three equations of lateral equilibrium by assigning suitable values to b and ϕ, but when this is possible the system is said to be inherently controllable.

In an inherently controllable system the rudder planes merely act as guides, and it is necessary that they should be so placed as to render the motion laterally stable.

In other cases steady motion can only be maintained by pressure exerted by the rudders or a couple applied by means of *ailerons* or some such action representing the third unknown variable required for the solution of the three simultaneous equations of lateral equilibrium.

(4) In a system of straight planes $\sin\phi$ is proportional to the radius a of the envelope, but it also appears that the other conditions of lateral equilibrium are only possible when pressure is applied by means of a rudder, and when a and ϕ have certain definite values. The only way of varying the radius of the circle actually described is by varying the position of the turning point, which may be in front of or behind the centre of gravity.

The addition of boxed-in ends or vertical partitions improves the steering, but it still leaves $\sin\phi$ proportional to a. The inference one would naturally derive from the formulæ is that all such systems would be liable to sway from side to side of the straight path in curved arcs of finite radius. In no case can the radius of the circular envelope exceed the limit corresponding to $\phi=90°$.

(5) With bent-up wings, as in the "Antoinette type," it is possible to satisfy the conditions of equilibrium so that a is no longer limited and ϕ no longer large. Such a system can be steered in a circle of large radius without being inclined at a large angle.

In general, circular motion can only be maintained when pressure is applied by means of a rudder or a couple applied by means of *ailerons*, but if the two principal moments of inertia about axes perpendicular to the line of flight are equal, the rudder exerts no pressure, and the system is inherently controllable, the inclination satisfying the relation $U^2=ga\tan\phi$.

(6) Another kind of "inherent controllability" in which the system always remains level, the inclination ϕ being zero, is possible in certain systems. A necessary condition is that the wings should be bent downwards and not upwards at the tips, and it will be usually advantageous that they should be most bent down at their extremities. The condition representing this fact is that the space between the wings and a chord joining their tips should be as large as possible.

This arrangement of the wings somewhat reproduces the action of gulls' wings in circling flight, and it will be found that differences in the form and curvature of the wings may have a considerable influence in the problems of this class.

(7) A third kind of "inherent controllability" is only possible when portions of the wing surface are in front of or behind the rest; and a possible solution exists in the form of a system suggested by the lecturer in the *Aëronautical Journal*, with front and rear planes, one set being turned upwards and the other downwards.

It appears, however, from the analysis that the necessary conditions cannot be satisfied in the case of surfaces of uniform breadth bent up into a plane dihedral angle at the centre or bent into a trihedral angle at some points intermediate between the centre and tips. They can, however, be readily satisfied by *suitably* curving the wings or by varying their shape so as to make them as a rule broader towards the tips than near the base. The present arrangement has the further advantage that the system would not tend to turn round sideways if struck by a side gust of wind, and this should be worth trying experimentally.

(8) Although no attempt has been made to discuss the analytical conditions of inherent stability further than has been done in "Stability in Aviation," it appears from general considerations that the rudder plane at least in an inherently controllable system should be placed on the opposite side of the centre of gravity to the turning point, and that difficulties, probably instability, must necessarily occur if the rudder is between the centre of gravity and the turning point. It seems almost certain that the best position for the rudder is when it and the turning point are in the relative positions of the centres of suspension and oscillations of the system when treated as a compound pendulum.

EARLY RECOGNITION OF THE PHASES OF THE PLANET VENUS.

IN the April number of the Journal of the Royal Asiatic Society there is an article by Mr. Joseph Offord, entitled "The Deity of the Crescent Venus in Ancient Western Asia," which is of interest to astronomers as well as to archæologists, because it shows that the phases of this planet were undoubtedly detected at a very early era indeed.

The evidence adduced commences with a cuneiform inscription from Babylonia, of the time of Assurbanipal, which refers to the horn of the star, and another similar sentence is added from an undated tablet. Mr. Offord then proceeds to consider many statements, chiefly made in ancient inscriptions, as well as in the fragments of classic, Syrian, and Egyptian literature referring to the characteristics of Venus as a stellar goddess, which indicate that the crescent form of the planet at certain intervals was recognised and clearly set forth by the titles, myths, and observances connected with her as a deity. As is well known, Venus, the Asiatic Ishtar, Ashteroth, or Astarte, wore a horned headdress, and was called in consequence Ashtoreth-Karnaim—the Ashtoreth of the horns. The Chaldeans made her the daughter of Sin, the moon-god, because of her similar crescent phases to the moon.

Much of the confusion concerning the titles and attributes of Venus, as a deity, arose from different names being assigned to her as morning and evening star, whilst the classics sometimes erroneously ascribed any stellar goddess said to have crescent form to the moon, because they were unaware that the planet Venus possessed the same characteristic, although the Assyrians and other Semites had recognised this.

That Astarte of the Greeks, and Asheteroth of the Phœnicians was Venus is certain, and that she was only another name for the Chaldean Ishtar Mr. Offord shows definitely. That Ishtar was the morning star the cuneiform texts confirm in many ways. One of her titles, Dilbat, "the Announcer," is cogent in the case; also in a myth when seven evil spirits were said to have worsted the moon, temporarily (*i.e.* an eclipse), Ishtar became queen of heaven, because the moon's light having vanished, Venus had no rival in brilliancy. Moreover, Ishtar had titles such as Simua (horned) and Timua (curved), and is depicted as a cow. The exvotos in many Astarte temples were also cow-heads with large horns.

In the clear air of Mesopotamia it was possible to detect the phases of Venus, as Dr. Gretschel has shown is the case in Persia and Peru; and so Ishtar-Venus, the later Ashtoreth-Karnaim, is like so many other primitive concepts, a reasonable expression of astronomical symbolism, the horned emblem upon figures of the deity indicating the star associated with her name.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—Mr. G. A. Wills, and his brother, Mr. H. H. Wills, have just made an additional gift of 40,000*l.* to the University. Originally they gave 180,000*l.* for the purpose of erecting additional buildings, but as the accepted tender greatly exceeds that amount, they have now added 40,000*l.*, making a total benefaction of 220,000*l.* The council has decided, therefore, to proceed forthwith with the erection of the buildings.

CAMBRIDGE.—The late Dr. W. Aldis Wright, vice-master of Trinity College, bequeathed the sum of 5000*l.* for the use of the University library. The late Lady Margaret Huggins left 1000*l.* to the City of London School for the endowment of a scholarship in astronomy, tenable at Cambridge, to be called the "Sir William Huggins" scholarship.

Mr. A. E. Dixon has been reappointed assistant to the Downing professor of medicine, and Mr. R. H. Rastall has been reappointed additional demonstrator of geology.

LONDON.—Her Majesty the Queen has given the sum of 250*l.* to pay for the training and expenses of a student at the London (Royal Free Hospital) School of Medicine for Women for a five years' course. The money is part of a gift to the Queen from the wives of Freemasons, to help members of the professional classes who may be in difficulties owing to the war. The council will award the scholarship in July, 1915, to a student who intends to begin a course of study in the October following. The scholarship will be of the value of 50*l.* a year for five years, subject to the student pursuing her course to the satisfaction of the council.

At a meeting of the Senate on May 19, it was decided to close the science department of Goldsmiths' College at the end of the present session.

Dr. A. E. Boycott, F.R.S., has been appointed director of the Graham Research Laboratory in succession to Dr. Charles Bolton.

The D.Sc. in chemistry has been granted to Mr. Percy May, of University College.

There are few changes in the *personnel* of the Senate as the result of recent elections. Dr. H. B. Workman succeeds Dr. T. L. Mears as one of the representatives of arts graduates, and Dr. W. P. Ker succeeds Dr. Pollard as one of the representatives of the faculty of arts. Mr. J. L. S. Hatton and Dr.

A. D. Waller have been re-elected as representatives of the faculty of science.

A course of four lectures on the gases of the blood will be given in the Physiological Laboratory, King's College, Strand, W.C., by Prof. T. G. Brodie, at 4.30 p.m., on May 31, and June 2, 7, and 9. The lectures, which will be illustrated by experiments, are addressed to advanced students of the University and others interested in the subject. Admission will be free, without ticket.

In recognition of his services to technical education, Sir Philip Magnus will be presented with an address and Lady Magnus with a piece of plate by the Association of Technical Institutions on Wednesday next, June 2. Mr. J. H. Reynolds, ex-president, will present the address, and Sir William Mather, the first president, will make the presentation to Lady Magnus. Sir Alfred Keogh, K.C.B., will preside.

It is announced in the issue of *Science* for May 14 that the Rensselaer Polytechnic Institute has received two substantial gifts recently. Mrs. Russell Sage has given 20,000*l.*, and Mr. A. T. White, of Brooklyn, 10,000*l.* From the same source we learn that a trust fund of 1000*l.*, to be known as the "Edward Tuckerman Fund," designed to increase the interest in the study of botany among the students of Amherst College, has been bequeathed to the college by the late Mrs. S. E. S. Tuckerman, wife of the late Prof. E. Tuckerman.

The governing body of the Manchester Municipal School of Technology (University of Manchester) is offering not more than ten research scholarships in technology during the session 1915–16 at the Manchester School of Technology—one of the value of 80*l.*, three of the value of 75*l.*, and six of the value of 50*l.*, all with fees remitted. Research may be undertaken in mechanical, electrical, or sanitary engineering; in any of seven branches of applied chemistry; and in textile industries. The scholarships are open to graduates of any university in the British Empire, and to other persons possessing special qualifications for research. Holders of the scholarships will be expected to devote the whole of their time to the prosecution of the research upon which they are engaged. The scholarships may be renewed for a second year on the recommendation of the Board of Studies. Forms of application and all information may be obtained, by letter only, addressed to the registrar, School of Technology, Manchester, and all applications must be received on or before June 21.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, April 27.—Prof. E. A. Minchin, vice-president, in the chair.—Mrs. R. Haig **Thomas**: White-collar Mendelising in hybrid pheasants. The paper was based on an examination of the relative numbers of dark-necked and ringed male pheasants shot during two seasons. The data collected were interpreted as providing evidence of the continual Mendelising which occurred in the collar of hybrid birds.—E. G. **Boulenger**: Two new species of tree-frogs from Sierra Leone.—E. **Heron-Allen** and A. **Earland**: Foraminifera of the Kerimba Archipelago, Portuguese East Africa. Part ii. The contents of this part were chiefly systematic, more than 470 species and varieties being dealt with, of which thirty-two are new to science.

May 11.—Dr. A. Smith Woodward, vice-president, in the chair.—Miss E. A. **Fraser**: The head-cavities and development of the eye-muscles in *Trichosurus vulpecula*, with notes on some other Marsupials. The usual eye-muscles, including a well-developed m. retractor bulbi, are present in the Marsupialia. A large premandibular head-cavity, representing the first somite of the head, is found in all the Diprotodontia, and appears to be either absent or of very small size in the Polyprotodontia.—Dr. R. **Broom**: (1) The Organ of Jacobson and its relations in the "Insectivora."—Part ii., Talpa, Centetes, and Chrysochloris. In Part i. it was shown that Tupaia and Macroscelides and their allies must be separated from the typical Insectivores, such as Erinaceus and Gymnura, to form a very distinct and not nearly related order—the Menotyphla. In Part ii. it is shown that Chrysochloris has no near relationship with either the Insectivora or the Menotyphla, and must be made the type of a distinct order, the Chrysochloridea. Centetes, which has hitherto been regarded as allied to Chrysochloris, is more nearly related to Erinaceus, though it differs from it in many points, and may later have been separated from it. Talpa shows many affinities with Erinaceus and a number of differences the value of which is at present not apparent. (2) The Anomodont genera, Pristerodon and Tropidostoma. Pristerodon, described by Huxley in 1868, is a very near ally of Dicynodon, differing mainly in having a series of molars which are smooth in front and have a series of denticulations behind. The males are tusked, the females without tusks. *Oudenodon raniceps* of Owen is a species of Pristerodon; while *Opisthoctenodon agilis*, Broom, and probably also *Opisthoctenodon brachyops*, Broom, are other species of Pristerodon. In 1889 Seeley described two occiputs under the names *Dicynodon microtrema* and *Dicynodon (Tropidostoma) dunni*. As pointed out by Lydekker, these belong to the one species, *D. microtrema*, and other specimens in the British Museum show that it differs from Dicynodon in the structure of the parietal region and in having molars very similar to those of Pristerodon, but fewer in number. This species is therefore placed in a distinct genus, for which the name Tropidostoma must be accepted.—Mrs. H. L. M. **Pixell-Goodrich**: Minchinia: a Haplosporidian. This papers deals with the life-history of *Minchinia chitonis* (Lankester), a protozoan parasite of the mollusc Chiton. Hitherto this parasite has been considered to belong to the Coccidia, but convincing evidence is here brought forward to show that it is a Haplosporidian. An account is given of the multiplication in the host by plasmotomy and sporogony, and a detailed description of the development of the very characteristic spores.

Linnean Society, May 6.—Prof E. B. Poulton, president, in the chair.—W. Percival **Westell**: Some bird problems. The author discussed anomalies of habit and structure in the order of the list recently issued by the British Ornithologists' Union, and asked for help in attempting to clear up some of the facts narrated.—Dr. Sarah M. **Baker** and Miss Maude H. **Bohling**: The brown seaweeds of the salt marsh.—II. Their classification, morphology, and ecology. Five of the species of Fucoideæ common in Britain as inhabitants of rocky shores are represented by peculiar varieties on the salt marsh. Evidence is brought forward to show that these forms, although they differ widely in their morphology from their rock ancestors, are to be regarded as adaptational varieties or "ecads" in the terminology of Clements. Two general methods have been used to study the correlation between the morphological peculiarities of the marsh Fucoids and the new chemical and physical conditions of their environment. The first is to study the distribution of natural varieties of one species, and the second to examine in detail exceptional cases. These methods have led to the conclusions that dwarf habit is mainly conditioned by exposure and lack of nutrient salts. Vegetative reproduction is caused by the high humidity maintained over the marsh in the intertidal periods. This prevents the attainment of a limiting concentration in the cell-sap necessary as a stimulus to the formation of sexual reproductive organs. The cause of spirality is probably unequal distribution of nutrient salts. The same factors were shown to be operative in causing the change in morphology of the floating Sargasso weed. Brown seaweeds may function on salt marshes either as pioneer vegetation, undergrowth, or covering vegetation after erosion, and in these capacities often play an important part in the economy of the marsh.—H. N. **Dixon**: A collection of Borneo mosses made by the Rev. C. H. Binstead.

Geological Society, May 12.—Dr. A. Smith Woodward, president, in the chair.—G. **Hickling** and W. R. **Don**: *Parka decipiens*, Fleming. The paper is a joint statement of originally independent investigations of this Old Red Sandstone organism. The views of Fleming, Hugh Miller, Mantell, Lyell, Powrie, Page, and others are quoted to illustrate the chequered career of this enigmatical fossil in geological literature. To Dawson and Penhallow, supported by Reid and MacNair, belongs the credit of making the first serious attempt to obtain definite evidence as to its nature, and of establishing its vegetable character. The present account is based on the observation of great numbers of specimens in the field, and on the microscopic study of impression-material, of thin sections, and of macerated material. The plant is most abundant in the Lower Old Red of the Kincardine-Forfar-Perth area, where it is by far the commonest fossil, especially in the shale-bands; Parka is confined to the lower two-thirds of the Caledonian Series. It is recorded from a few other localities in central Scotland, and also from the Upper Ludlow and Lower Old Red of the "Hereford" area. The organism is shown to be a complete cellular thalloid plant, agreeing generally in its vegetative structure with certain algæ, but differing from all known algæ in the production of cuticularised spores.

Institution of Mining and Metallurgy, May 20.—Sir T. K. Rose, president, in the chair.—J. J. **Beringer**: The physical condition of cassiterite in Cornish mill products. This paper was in course of preparation when the author contracted an illness which ended fatally, and as a consequence it lacks the valuable summary of conclusions which the author would have compiled as the result of his exhaustive series of experiments in a subject to which his last few years had been largely devoted. He had, in fact, made most detailed investigations into the mode of occurrence of the particles of cassiterite in the ores of Cornish lodes and in the mill products resulting from the reduction of those ores, with a view to reducing the losses on the dressing floors. The chief conditions governing his investigations were: the actual measurement of the sizes of the particles; the determination of the rate at which particles of various sizes settle in still water and against upward currents, with methods of separating and collecting particles of a given size; the compilation of tables showing specific gravity and assay value of particles in relation to their size; a study of the action of particles of various sizes in their passage over various forms of concentrating machinery; and, finally, an investigation of some special mill-products, and a general study of the mineral cassiterite as found in some Cornish lodes. For reporting the mean diameter of particles as measured under the microscope the author used the micrometric unit of one-thousandth of a millimetre, and established a relationship between that form of measurement and a classification based on the rate of falling in still water and the different rates of upward current between which the particles in a mixture can be separated. The paper contains an attempt to give a definite size value to the much-discussed terms "sand" and "slime," with further subdivisions of the latter condition into "silt," "fine silt," and "clay." A valuable section of the paper deals with the action of the material when passing over concentrating machinery, different types of which were experimented with in great detail. In an appendix are given valuable hints on the uses of the microscope in determining the size and nature of minerals, a subject which Mr. Beringer brought forward at a meeting of the institution shortly prior to the preparation of the material embodied in this paper.—H. F. **Collins**: Note on the concentration of gold in bottoms in the converter. With a view of utilising the gold contents of converter copper which is not rich enough to make electrolytic refining profitable, by means of a partial oxidation of the bath of white metal to "pimple" metal and "bottoms," and the separation of the latter before completing the oxidation, the author devised a simple method of treatment which has been in actual practice for about a twelvemonth. In this method a small acid-lined converter is used, provided with a taphole opposite the tuyeres, which, during the process of blowing to precipitate, is closed by a plug of clay attached to an iron rod. When the metal is thoroughly molten, the bar is withdrawn and the copper allowed to run off into moulds until white metal appears in the stream, when the taphole is closed and the converter returned to position for the next similar operation. The success of the method depends primarily on running the charge hot, losing no time in skimming and not adding too much cold scrap after skimming, so that the reduced copper is well above the melting point of "pimple" metal.—Donald M. **Levy** and Harold **Jones**: The Morro Velho method of assay of gold-bearing cyanide solutions. The method here described is based on the precipitation of the gold by means of a zinc-lead couple from the boiling solution in the presence of suitable quantities of silver and lead salts. By this means, sufficient silver is introduced to yield with the gold a suitable parting alloy. The presence of the lead salts causes the production of a lead-zinc couple which facilitates the complete liberation of the metallic gold from solution, and yields a bulky precipitate of the lead and values which settles easily and thus ensures carrying down the precipitated gold.—F. A. **Eastaugh**: The effect of different methods of crushing on the ash of coke. The object of the experiments here described was to find the true ash contents of the coke, in order to discover whether the discrepancies occurring so frequently between the amount of ash found by sellers and buyers are due to different methods of preparing samples for test purposes. In the experiments, all made from one parcel of metallurgical coke, remarkable differences resulted from the employment of different methods of crushing the samples.

PARIS.

Academy of Sciences, May 17.—M. Ed. Perrier in the chair.—G. **Humbert**: The positive binary quadratic forms.—D. **Eginitis**: Observations of the Mellish comet (1915*a*) made at the Observatory of Athens with the Doridis equatorial (40 cm.). Positions are given for April 8, 10, 13, 14, 15, 21, and 22.—Ernest **Esclangon**: The quasi-periodic integrals of a linear differential equation.—Maurice **d'Ocagne**: Remarks on the subject of circular anamorphosis.—A. **Buhl**: New geometrical applications of the formula of Stokes.—Daniel **Berthelot**: Calculation of the Despretz-Trouton constant. By combining the equation of Van der Waals with the law of the rectilinear diameter of Mathias, the ratio of the internal latent heat of vaporisation to the absolute boiling point was found to be 9, or half the experimental value. But using the characteristic equation for a gas given by the author in 1900, in place of the Van der Waals equation, the Despretz-Trouton constant is 18, in exact accord with experiment.—E. **Léger**: Magnesium citrate and the supposed basic magnesium citrates.—O. **Bailly**: The synthesis of α-glycerophosphoric acid. Sodium allylphosphate, treated with potassium permanganate, gives the α-glycerophosphate free from the β isomer. The solubilities of the calcium, barium, and strontium salts were determined.—J. **Bergonié**: The detection, localisation, and extraction of magnetic projectiles by means of the electro-vibrator. A summary of the advantages of this method as compared with the usual surgical operation with the assistance of the X-rays.—Félix **Legueu**: Biological reactions in prostatic adenoma.

BOOKS RECEIVED.

Catalogue of the Ungulate Mammals in the British Museum (Natural History). Vol. iv. By R. Lydekker. Pp. xxi+438. (London: British Museum (Natural History); Longmans and Co., and others.) 10*s*. 6*d*.

The Principles of Agriculture through the School and the Home Garden. By C. A. Stebbins. Pp. xxviii+380. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 4*s*. 6*d*. net.

Societal Evolution. By Prof. A. G. Keller. Pp. xi+338. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

A Report on Library Provision and Policy by Prof. W. G. S. Adams to the Carnegie United Kingdom Trustees. Pp. 104. (Edinburgh: Neil and Co.)

Three-Colour Photography: with Special Reference to Three-Colour Printing and Similar Processes. By A. Freiherrn von Hübl. Translated by H. O. Klein. Pp. 138. (London: P. Lund, Humphries and Co., Ltd.)

The Material Culture and Social Institutions of the Simpler Peoples. By L. T. Hobhouse, G. C. Wheeler, and M. Ginsberg. Pp. 299. (London: Chapman and Hall, Ltd.) 2*s*. 6*d*. net.

Surveying and Field Work. By J. Williamson. Pp. xxii+363. (London: Constable and Co., Ltd.) 7*s*. 6*d*. net.

Single-Phase Electric Railways. By E. Austin. Pp. xiv+303. (London: Constable and Co., Ltd.) 21*s*. net.

La Science Allemande. By Prof. P. Duhem. Pp. 143. (Paris: A. Hermann et Fils.)

Continuous Current Electrical Engineering. By W. T. Maccall. Pp. viii+466. (London: University Tutorial Press, Ltd.) 10*s*. 6*d*.

DIARY OF SOCIETIES.

THURSDAY, MAY 27.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 28.

ROYAL INSTITUTION, at 9.—Engineering Problems of Mesopotamia and Euphrates Valley: Sir John Jackson.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Evolution of the Oil Tank-ship: H. Barringer.

PHYSICAL SOCIETY, at 5.—Numerical Relations between Electronic and Atomic Constants: Dr. H. S Allen.—A Method of Calculating the Absorption Coefficients of Homogeneous X-Radiation: H. Moore. Two Experiments Illustrating Novel Properties of the Electron Currents from Hot Metals: Prof. O. W. Richardson.—High Permeability in Iron: Prof. E. Wilson.—An Experiment showing the Relative Width of Hydrogen and Neon Lines: T. R. Merton.

SATURDAY, MAY 29.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

MONDAY, MAY 31.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Geography of the War Theatre in the Near East: D. G. Hogarth.

TUESDAY, JUNE 1.

ROYAL INSTITUTION, at 3.—The Evolution of Steel—Influence on Civilization: Prof. J. O. Arnold.

RÖNTGEN SOCIETY, at 8.15.—Annual General Meeting.

WEDNESDAY, JUNE 2.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Estimation of Starch in Cocoa by the use of Taká Diastase: C. Revis and H. R. Burnett.—The Volumetric Estimation of Ferrocyanides: B. Campbell.—Corean Beeswax: Seiichi Ueno.—Determination of β-Naphthol in Lysol and similar compounds: R. Bodmer.—The Composition of Dutch Cheese: J. J. L. van Ryn.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, JUNE 3.

ROYAL SOCIETY, at 4.—*Probable Papers*: Soil Protozoa and Soil Bacteria: E. J. Russell.—The Chromosome Cycle in Coccidia and Gregarines: C. Dobell and A. P. Jameson.—The Influence of Gases on the Emission of Electrons and Ions from Hot Metals: Prof. O. W. Richardson.—The Shapes of the Equipotential Surfaces in the Air near Long Buildings or Walls, and their Effect on the Measurement of Atmospheric Potential Gradients: Prof. C. H. Lees.—The Band Spectrum associated with Helium: J. W. Nicholson.

ROYAL INSTITUTION, at 3.—Methods of presenting Character in Biography and Fiction: Wilfrid Ward.

FRIDAY, JUNE 4.

ROYAL INSTITUTION, at 9.—Radiations from Exploding Atoms: Sir E. Rutherford.

GEOLOGISTS' ASSOCIATION (at University College), at 8.—Lakes and their Origin, with Special Reference to Rock-basins: Prof. E. J. Garwood.

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THURSDAY, JUNE 3, 1915.

GERMANY AND THE MUNITIONS OF WAR.

In previous articles we have commented upon the stringency which will undoubtedly be felt in time by our enemies in regard to the provision of certain raw materials which are absolutely essential to the manufacture of munitions of war. All accounts which are allowed to leak through from Germany and Austria clearly indicate that this stringency is now becoming acute, and with the advent of Italy as another of our Allies, it will rapidly become almost insurmountable.

From an article which appears in the last issue of the *Engineering and Mining Journal* of New York, based upon a communication made by the director of a great German metallurgical company to an American correspondent, we gather that the shortage is frankly admitted, and some account is given of the desperate efforts which are being made by our enemies to meet it. Germany has evidently summoned to her assistance all the metallurgical skill and chemical knowledge at her disposal in attempts to improvise substitutes for the materials of which she has been deprived by the effectiveness of our blockade. That she will to some extent succeed may be conceded, for ordinary commercial conditions are no longer applicable to the case of a nation which has "its back to the wall," and is determined to stake everything, regardless of human life and treasure, in the struggle to preserve its existence. But whilst these attempts may do credit to the intelligence and resourcefulness of our enemies, and may serve to illustrate their undoubted organising capacity, they are clear proofs of the straits to which they are reduced.

Such attempts may prolong the duration of the struggle, but it is highly improbable that they will materially affect its ultimate result. It is possible that gun cartridges, rifle cartridges, and the fuse-heads of grenades may be made without the use of copper or brass, or with alloys containing only a minimal proportion of copper, but it is unlikely that such substitutes will prove as efficient as the material hitherto used. It must be remembered that the strongest arm of the enemy's service is its artillery, and anything that militates against the efficiency of that branch *pro tanto* weakens the enemy's power.

Supplies of cotton are almost unavailable to Germany and Austria; the closing of the Italian ports has effectively cut off some lines of importation of this commodity. Other sources of cellulose are, of course, open to them, and other forms of nitro-cellulose than ordinary gun-cotton are being made and are said to be in use with what is stated to be "unobjectionable" results, which rather sounds like damning with faint praise.

It is admitted that we have also cut off all supplies of petrol and petroleum, but as regards the use of the former substance in internal combustion engines, benzene, which is obtained by the destructive distillation of coal, is claimed to be a satisfactory substitute. This may be more or less true of ordinary motor-driven vehicles, especially in summer; but benzene is apt to freeze at low temperatures, and this circumstance has undoubtedly led to trouble in air-craft flying at high elevations in winter. Ordinary gasolene consists largely of pentane and amylene, and no doubt these hydrocarbons can be produced synthetically, if cost is no object. Indeed, it is claimed that German chemists have worked out two synthetic processes which are actually in operation, and are said to be so far successful that Germany is assured of internal supplies, even after the conclusion of the war. Acetylene has largely replaced petroleum as an illuminant, and is in use even in safety-lamps, and it is possible that the substitution may be more or less permanent, unless, which is unlikely, steps are taken on the conclusion of peace to reduce the relatively high price of burning oil consequent on the import duty and the operations of the American, Russian, and Dutch Trusts.

Germany also now claims to be independent of any external supply of nitrates. It is stated that "within a short time enormous works will have been erected, which will convert the nitrogen of the air into ammonia, and thence, by its combustion, into nitric acid"—one works alone turning out about 80,000 tons of nitric acid yearly. It may be confidently asserted that before this consummation is reached the war and all its doings will have been relegated to the domains of history.

Nitric acid can only be made commercially by the use of oil of vitriol, and there is ample evidence that the growing scarcity of the raw materials upon which the manufacture of the latter substance depends is causing great perturbation in chemical circles in Germany. All outside sources of sulphur, whether as such or as pyrites, are excluded. The use of sulphuric acid for the manufacture of fertilisers is practically prohibited. Attempts are being made to convert ammonium carbonate, obtained by the Haber process, into ammonium sulphate by treatment with gypsum—a process already used in France with only partial success; and various methods of obtaining sulphuric acid from Epsom salts and other alkaline earth sulphates are being tried, with what probable result may be judged of from Lunge's well-known work on sulphuric acid manufacture, in which prior attempts to make use of such processes are described in more or less contemptuous terms. Indeed, the patent literature of every country is evidently being ransacked in the dire necessity which has now overtaken our enemies, and all sorts of suggestions, many of which have been tried and hitherto found wanting, are being exploited with a feverish activity.

The problem which confronts a Minister of Munitions in Germany is gradually becoming hopeless, unless he is given practically unlimited time in which to solve it. He has the men, who are working with a unanimity and a strenuousness which compels our respect and admiration, and the intelligence, knowledge, and skill of the captains of industry and all their appliances are at his disposal. But he cannot make bricks without straw, and the straw is gradually being denied him, struggle as he may. To us and to our Allies—thanks to our command of the sea—the world is all before us where to choose, and we have access to all the raw material we need. To our Minister of Munitions the problem is not want of material; it is want of men, and the lack of that strenuousness of purpose and of determination, energy, industry, and fixity of effort which have been imbued into the whole German nation. Time is of the essence of the situation, and to waste it in political bickerings, squabbles about profits and war bonuses, labour troubles, strikes, and "slackness" is to play directly into the enemy's hands and to prolong the agony and wretchedness under which the whole civilised world is now suffering.

EXPLOSIVES: ANCIENT AND MODERN.

Explosives: their Manufacture, Properties, Tests and History. By A. Marshall. Pp. xv+624. (London: J. and A. Churchill, 1915.) Price 24s. net.

IT is twenty years since any really important and comprehensive book on the subject of Explosives has been published in England, and the time was therefore ripe for a work that should bring the subject up to date and present it as a whole. In doing this, however, it is obvious that in such a wide and highly specialised field of work it is necessary to exercise the greatest care in selection and arrangement in order to avoid undue bulk of matter and at the same time to present the subject in the clearest possible way. This is the task that Mr. Arthur Marshall has set himself in "Explosives, their Manufacture, Properties, Tests and History," and the author has succeeded in giving us a most valuable book, which will be welcomed by all workers on the subject.

Part i. of the book is historical, and deals with the progress and development of explosives from Greek Fire to picric acid, and considerable space is given to Colonel Hime's translation of Roger Bacon's cipher instructions for the manufacture of gunpowder, and the reasons for supposing that the statements as to the great antiquity of gunpowder were inaccurate and based on erroneous translations. In this part of the book it is pleasant to find an appreciation of the wise and tactful manner in which Sir Vivian Majendie and his successors, Colonel Ford, Captain Thomson, Major Cooper-Key and their subordinates have carried out the working of the "Explosives Act" and have made it a boon to the workpeople without interfering with the development of the industry.

Part ii. is devoted to black powder, and three chapters are given to the preparation of the ingredients and manufacture, but nothing is said as to the reactions taking place on the firing of gunpowder under varying conditions, and although the products of explosion of R.L.G. powder as determined by Nobel and Abel are given, not a word is said of such historical researches as those of Bunsen and Schischkoff Linck, Karolyi and Debus.

Part iii. contains three chapters dealing with the manufacture of sulphuric acid and nitric acid, and the manipulation of waste acids. Although the preparation of nitric acid from Chile saltpetre is very fully described, the production of nitric acid from the air is dismissed in eight lines, which seems strangely inadequate in view of the Germans being at the present time largely dependent upon synthetic nitric acid for the preparation of their high explosives.

Part iv. is on the nitric esters of carbohydrates, and commences with a chapter on the Theory of Nitration of Cellulose, which gives the work done by many observers fairly fully, and then suddenly branches off to the commercial uses of pyroxylin and collodion. Following this come chapters on cellulose, manufacture of nitro-cellulose, stabilisation of nitro-cellulose, and the nitric esters of other carbohydrates.

Part v. deals equally fully with the nitric esters of glycerin, whilst smokeless powders occupy Part vi.

These first six divisions of the book contain twenty-one chapters, and deal with the class of explosives that may be called "propellants." In reading them two criticisms arise—the first being that the subject matter is so subdivided as to destroy continuity, and the second is that a vast amount of detail as to manufacture and history of the explosives has been presented to the reader without any attempts being made to give an idea of the principles on which the composition and action of explosives depend. The explanation of this is probably to be found in the statement made in the preface that "subjects which are treated fully in the ordinary scientific or technical text-books have only been dealt with in so far as they throw new light on problems connected with explosives."

This limits the utility of the book, as although a collection of widely scattered results from many sources is a great help to the workers in the subject, the addition of a chapter in the early part of the book, dealing with the principles on which the subject rests, would have enormously extended the public to which the work would appeal.

The next portion of the book deals with blasting explosives, and in Part viii. we come to the properties of explosives, such as their physical character, the pressure and heat, power and violence of explosion, and a chapter on ignition and detonation.

Part ix. is devoted to special explosives, such as fuses, safety explosives and fireworks. The chapter on safety explosives gives an interesting account of the testing galleries to be found in the mining centres of various countries, and the procedure adopted for testing the liability of explosives to ignite mixtures of coal gas or methane and air, and also coal dust suspended in air. The whole chapter is so well done that it is a pity that the author does not point out more strongly that the class of explosives to which these methods of testing have given rise are safe in name only, as those in which nitroglycerin is the explosive basis are so diluted with carbonaceous matter as to give on explosion volumes of carbon monoxide, a poisonous and inflammable gas, whilst the ammonium nitrate class often contains so large an excess of this salt, used in admixture with trinitrotoluene or other explosive body as to give an excess of oxygen, which must always be a danger in a coal bore.

Part x. deals with stability, whilst in Part xi. materials and their analysis are fully discussed.

Throughout the thirty-six chapters in which the book is divided full references are given to the original memoirs from which quotations are made, whilst there is an appendix and an index of names as well as of subjects.

FEEBLE-MINDEDNESS.

Feeble-mindedness: its Causes and Consequences. By Dr. H. H. Goddard. Pp. xii+599. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 17s. net.

THIS is the most recent American work dealing in an authoritative and scientific manner with what is now known in this country as mental deficiency. Some years ago Binet and Simon devised a method of classifying mentally defectives according to the degree of intelligence they had attained, comparing the results of certain tests with those obtained from normal children of various ages. Thus, mentality 4 means that the patient has attained the intelligence of a child aged four years. This classification is adopted throughout the present work, certain general terms being used in accordance with the American general classification on the same basis. Patients of mentality 1 or 2 are called idiots, those of mentalities 3 to 7 are called imbeciles, and those from 7 to 12 are called morons.

In some preliminary remarks respecting the relationship of feeble-mindedness to certain other social evils, the author quotes statistics or competent opinions which seem to show that at least 50 per cent. of criminals, prostitutes and paupers (inmates of almshouses), many ne'er-do-wells and some alcoholics are feeble-minded. It is also mentioned that 80 per cent. of truants are feeble-minded, the explanation being that truancy is the result, and not the cause, of failure in school-work.

The greater part of the book is devoted to the study of heredity in relation to feeble-mindedness. This investigation is so thorough that it comprises the labours of a whole field of trained investigators, for it is clear that no one man could carry out by himself the enormous amount of work recorded in Dr. Goddard's book. Not only is a detailed family history obtained, but as many members of the family as possible are personally seen and examined or, when this is not possible, inquiries are made of the inhabitants of the village where the person lived respecting his intellectual capacity. In this way a history is obtained of every individual member of the family tree for three, four, five or, in one case, six generations back. When we reflect how few of us could give particulars of so many of our ancestors, we can appreciate the amount of labour which has been expended in this field.

In chapter v. the author collects the data of his charts in a series of twenty-one tables and shows the etiological influence, positive or negative, of alcoholism; paralytic, epileptic, insane or syphilitic parentage or affection; tuberculosis; sexual immorality; blindness and deafness; consanguinity; neuroses, etc. This chapter cannot be abstracted but, in the succeeding chapters, the author discusses the Mendelian law and its relationship to feeble-mindedness.

Dr. Goddard appears to be disappointed with his conclusion that *general intelligence* is a unit character, although several psychologists (Burt, Hart, Spearman and others) have amply demonstrated this truth from other points of view; and his figures agree so closely with Mendelian views that he feels justified in stating that "normal-mindedness is, or at least behaves like, a unit character; is dominant and is transmitted in accordance with the Mendelian law of inheritance." From this it is to be inferred that feeble-mindedness obeys the law as a recessive character.

Then comes a chapter on eugenics, in which the author states, in opposition to Mott, that feeble-mindedness does *not* tend to run itself out of a family, and considers that the stock might be improved if something were done on eugenic principles. Colonisation and vasectomy he regards as generally impracticable, and is rather inclined to some form of control of matings. Most people will regard this also as impracticable, at least in this country.

The book contains a mass of information to which no reference has been made in this review, and we have no hesitation in saying that it should be on the shelf of every statesman and asylum medical officer in the country.

There are some curiosities in spelling, such as "thot," "thotless," "thru," "thruout," "altho," and "tho"; but the book is good, the illustrations are good, the index is good, and we commend the author on an admirable production. The volume is well got-up and presents a dignified appearance, but it possesses the common American fault of being rather heavy for its size.

SYSTEMATIC NATURAL HISTORY.

(1) *Flora of Jamaica, containing Descriptions of the Flowering Plants known from the Island.* By W. Fawcett and Dr. A. B. Rendle. Vol. iii. *Dicotyledons: Families Piperaceae to Connaraceae.* Pp. xxiv+280. Plates i–v, text-figures 1–113. (London: British Museum (Natural History) and Longmans, Green and Co., 1914.) Price 15*s*.

(2) *The Fauna of British India, including Ceylon and Burma. Mollusca,* ii. (*Trochomorphidae to Janellidae.*) By G. K. Gude. Pp. xii+520, text-figures 1–164. (London: Taylor and Francis, 1914.) Price 20*s*.

(3) *Catalogue of the Amatidae and Arctiadae (Nolinae and Lithosianae) in the Collection of the British Museum.* By Sir G. F. Hampson. Pp. xxviii+858, text-figures 1–276. (London: British Museum (Natural History) and Longmans, Green and Co., 1914.) Price 25*s*.

THE verse in which Catullus describes the three volumes of Chronica written by his friend Cornelius Nepos may well be applied to the three works above named, "Doctis, Juppiter, et laboriosis." Though by different authors, they agree in displaying the unwearied industry with which modern naturalists of eminence examine and re-examine, compare and classify, name and (occasionally) re-name, the objects which Nature, their patroness, offers in seemingly endless variety.

(1) The botanical volume is usefully illustrated by detailed figures for one species in each genus, and provided throughout with helpful keys for the discrimination of families, genera, and species. Here and there economic and other untechnical notes are introduced, as in the Annonaceæ, on what is good to eat or otherwise. A bibliography occupying several pages with more than two hundred entries is some evidence of exhaustive research, and credit is given to fifty-six collectors and contributors of specimens. This interesting list covers a period of more than two centuries, beginning with H. Barham as earliest and longest in the field (1680–1726), and concluding with Mr. and Mrs. N. L. Britton (from 1906) and Mr. J. R. Bovell (from 1914) down to the present time. As might be expected, there are many well-known names in the intermediate group; for example, Sir Hans Sloane in the seventeenth century, Patrick Browne in the eighteenth, Philip Henry Gosse in the earlier half of the nineteenth, and in the latter half Sir Daniel Morris (1879–1886), and William Fawcett (1887–1908), the last-named by his former position as director of public gardens and plantations in Jamaica being exceptionally qualified for the joint-authorship of the present flora. Charles Kingsley's visit to the West Indies did not include Jamaica, but his attractive volume "At Last" offers an observation that may well apply to it. Referring to West Indian weeds, he says:—

"So like home weeds they look: but pick one, and you find it unlike anything at home. That one happens to be, as you may see by its little green mouse-tails, a pepper-weed (Peperomia), first cousin to the great black-pepper bush in the gardens near by, with the berries of which you may burn your mouth gratis. So it is, you would find with every weed in the little cleared dell, some fifteen feet deep, beyond the gravel. You would not—I certainly cannot—guess at the name, seldom at the family, of a single plant."

Fawcett and Rendle state that there are more than six hundred species of Peperomia, and they carefully discriminate thirty-six species as occurring in Jamaica, in the distribution of five naming Trinidad, with which Kingsley was concerned. Unfortunately in their technical keys and descriptions they do not take into account "little green mouse-tails" as a distinguishing character! This omission does not prevent our perceiving how great a boon this work of theirs will be to all botanists, amateur as well as professional, to whom the West Indian flora makes any sort of appeal.

(2) and (3) Turning now to the zoological treatises, in two trifles, regarding not matter but mode, the reader may find Mr. Gude's volume better to his liking than its companions. Its alphabetical index is simple and continuous for genera and species, whereas the botanists less conveniently divide up theirs into a simple series for the genera, but for the species as many separate series as there are genera. Sir George Hampson's alphabetical index agrees in principle with Mr. Gude's, but parsimoniously omits several generic names altogether. Also, like the botanists, where no saving of space can be pleaded, he disfigures names of authorities by abbreviation, supplying such forms as Butl., Dogn., and the unpronounceable Wllgrn. and Hmpsn., to compare with the equally illustrious botanical writers Miq., Moq., and Mill., Ham., and Jacq., Nutt., Plum., and Tréc.

Sir G. Hampson reports that since the first and second volumes of the "Catalogue of Moths" were published in 1898 and 1900 respectively, to a total of 426 genera and 2401 species in one family and part of another, there have been added ninety genera and 1941 species, the monstrous increase dealt with in the present volume.

Similarly in Mr. Gude's work, the family of Helicidæ alone occupies nearly 200 pages, though far from covering the complete distribution of these familiar snails. In this subject the growing importance of malacology is ever tightening its grip upon conchology, the immediate effect being to expose earlier classification at many points to serious need of revision. An enthusiast in the eighteenth century, wishing to teach mankind how to estimate character by the curves and angles of the forehead, says, "For this purpose, I would advise the physionomist to procure a collection of sculls of well-known persons," evidently expecting that well-known persons would readily lend their skulls in the interest of scientific investigation. The modern student of mollusca wants, not so much the skull-cap so prized by the conchologist, as the molluscous body, to dissect out the radula with its ribbon of (often multitudinous) teeth, to examine the intimate parts of the hermaphrodite structure, and to note, it may be, as Mr. Gude has done in the genus Corilla, curious differences between immature forms and their parents.

Both our zoologists evidently intend to uphold the pedantic, inconvenient, and unscholarly rule that the specific name should agree in gender with the generic. The rule is unscholarly, because, while all sexual species of animals contain male individuals, the Latin tongue gives a preference to the masculine gender, where it has to do with genders in combination. The rule is inconvenient, because cases are continually occurring, as has been several times shown, in which naturalists are deceived as to the real gender of a generic name. Had he been content to leave specific names in the masculine gender, Mr. Gude would have been spared three out of the seven items of his list of errata. Yet in the body of the work he leaves *Pupisoma miccyla* (neuter and feminine) by the side of *Pupisoma cacharicum*, and, while himself using *P. constrictum*, quotes Godwin-Austen for *Pupa* (*Pupisoma*) *constrictus*. He treats *Zootecus* as masculine, though by its termination it should be regarded as neuter. In like manner among the moths we have the generic names Sphecosoma, Chionaema, Chrostosoma, Cosmosoma, Empyreuma, neuter forms, all treated as feminine, though apparently by accident *Sphecosoma nigrifer* escapes a change into *nigrifera*. Why the genus Mesothen, with a Greek adverb for sponsor, should be deemed feminine, remains obscure. But, apart from any grammatical mysteries, it remains clear that the several authors have applied much sound learning and solid labour to their very arduous tasks.

T. R. R. STEBBING.

OUR BOOKSHELF.

Ancient Hunters and Their Modern Representatives. By Dr. W. J. Sollas. Second Edition. Pp. xxiii+591. (London: Macmillan and Co., Ltd., 1915.) Price 15s. net.

PROF. Sollas's treatise on prehistoric archæology having the title of "Ancient Hunters and their Modern Representatives" was published four years ago. We are not surprised to know that the first edition was soon exhausted, for the book was well designed to meet the needs of a large public. In the present edition the author has incorporated accounts of the more recent discoveries relating to ancient man, including Mr. Dawson's important find at Piltdown. Prof. Sollas had anticipated the discovery of such a form as Eoanthropus "as an almost necessary stage in the course of human development." He apparently differs from Dr. Smith Woodward as regards the antiquity and size of brain of

Eoanthropus, assigning this human form to the "latter half of the Pleistocene" and giving its cranial capacity as "at least 1070 c.c." Dr. Smith Woodward came to the conclusion that Eoanthropus belongs to the older Pleistocene, and in his more recent reconstruction of the skull represents the cranial capacity as 1300—230 c.c. above his original estimate.

Prof. Sollas sums up his final conclusion as regards human antiquity as follows: "that man, not only in the narrower, specific sense but also in the broader generic sense—Homo—is a product of the Pleistocene epoch, the latest child of time, born and cradled amongst those great revolutions of climate which have again and again so profoundly disturbed the equilibrium of the organic world." It will be seen from this extract that the author favours the older opinion that man made his first appearance at a comparatively recent date.

The Body in Health. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix+324. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

Of the making of books on elementary physiology and hygiene there seems to be no end, and the tendency to the multiplication of such manuals is specially marked in America. Perhaps this is an indication that our cousins across the sea are more alive to the importance of health in the well-being of a nation; they certainly make it a much more universal subject of school education than we do. The present volume has much to recommend it; it is clear, convincing and accurate; it is written in simple language and well illustrated; as a rule it is level-headed. The usual space, as in all American text-books of this kind, is devoted to the evil of alcohol; with that one has no quarrel; but tobacco also is regarded as nearly equally bad. The following is, for example, quoted with approval: "I know whereof I speak when I say that tobacco when habitually used by the young leads to a species of imbecility; that the juvenile smoker will lie, cheat and steal things he would not do had he let tobacco alone." Extravagant superlatives of this nature often do more harm than good.

W. D. H.

LETTERS TO THE EDITOR.

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

Ultra-Violet Excitation of the D Line of Sodium.

In a letter on this subject published in Nature, May 13, I showed that sodium vapour, stimulated by the second line of the principal series at wave-length 3303 in the ultra-violet, fluoresces with emission of the D line, which is the first member of the principal series.

Each of these lines is a doublet. The interesting question arises, Supposing that stimulation were confined to one member only of the ultra-violet doublet, should we get emission only of the corresponding member of the D line, or would both components of the D line be emitted? The first alternative seemed *a priori* more probable, taking into account the result of Wood and Dunoyer, that if sodium vapour is stimulated by D light, one component of the D line is not able to give rise to fluorescent emission of the other.

I have, however, succeeded in carrying out an experiment which seems to decide fairly conclusively in favour of the second alternative. The zinc arc spectrum shows an ultra-violet doublet very near the sodium doublet. My attention was directed to this by reading Prof. Wood's account of his earlier attempts on the problem. Direct comparison of the spectra showed that the zinc doublet lay inside the sodium doublet, but that while one of the zinc components was situated at about one-twentieth of an Ångström from one sodium component, and thus very nearly in coincidence, the other zinc component was four times as far from its sodium neighbour, and well clear of it.

A zinc vacuum arc in quartz was used to illuminate the sodium vapour bulb, interposing the filter mentioned in the former paper, for the suppression of visible light. With currents of three or four amperes nothing could be seen. Increasing the current to six amperes, a faint emission of D light was observed. It was as yet too faint for spectroscopic examination, but was identified by the absorption methods described in the former letter. At 15 amperes, the light was bright enough for a specially designed spectroscope, and showed *both components of the D line in about equal intensity.*

The current was increased in successive tests to about 100 amperes. These large currents were only kept on for two or three seconds so as to avoid destroying the lamp. For this short time the fluorescence was not inferior in intensity to the light of a moderately salted Bunsen flame, and the components of the D line were seen very bright. The intensity increases very rapidly with the current through the lamp. This is due partly, of course, to the greater brightness, but more to the broadening of the first zinc component, which makes it definitely overlap the first sodium component. Possibly at very large currents this cause may even bring the second zinc component on to the second sodium component, but plainly the first overlap must come in much sooner, for the interval to be bridged is four times less; and at the lowest current which brings out the D line brightly enough for examination, its components are approximately equal.

Wood's failure to get any D emission is probably to be explained by his not having used a heavy enough current through the zinc lamp to secure an overlap of the zinc and sodium lines.

R. J. Strutt.

Imperial College of Science, South Kensington,
May 31.

On the Sealing of Electrical Conductors through Glass.

At the present time there is great difficulty in obtaining soft glass with a comparatively high coefficient of expansion, suitable for sealing wires into glass tubes, bulbs, etc. The pre-war imported stocks of glass for this purpose are exhausted, and the recently published results of glass research committees do not contain formulas for its manufacture. About three years ago, Mr. George B. Burnside, of the natural philosophy department of the University of Glasgow, discovered a method of hermetically sealing electrical conductors through glass and other vitreous substances. The process is simple, and entirely obviates the use of a "flux" glass; and in view of the present needs, it seems advisable to bring this method again before the notice of those who may find it to their advantage to use it. A general description of the process appeared in the *Electrician* of July 4, 1913; but the method does not seem to have become so popular as might have been expected from the simplicity and ease of its application. As to the results obtained, the following facts from my own experience may be mentioned as affording proof of its absolute perfection.

In the course of some research work which is being carried on at present in Prof. Gray's laboratory, involving the examination of certain resolved spectral lines, a Wehnelt electrolytic interrupter was used in connection with an 18-in. induction coil. This interrupter was employed on account of the fact that, with it, the discharge can be allowed to run for hours without attention. The positive electrode was simply a small length of platinum wire sealed through the end of a glass tube. The wire conveying the current dipped into mercury surrounding the upper end of the sealed wire. At first the sealing of the platinum wire into the glass tube was done by means of a "flux" glass in the usual way. It was noticed, however, that after a few hours' working, as a result of the disruptive action of the interruptions, this glass round the anode became pitted out, a crater being formed with the wire projecting from its centre. This action may go on until a leak occurs. Again, for the large currents used—more than 10 amperes—a fairly heavy wire is necessary, and the heating effect frequently causes fracture of the glass, by small radial cracks starting from the wire, or even from the junction of the two glasses. Both these effects are, of course, undesirable. The pitting out of the glass exposes a greater amount of the conducting material, and consequently alters the frequency; while leakage due to fracture considerably increases the amount of "steady current," that is, current spent in mere ordinary electrolytic effects.

To overcome both these defects, I used a piece of Jena glass tubing, with a small length of heavy platinum wire sealed directly into it by the Burnside method. This anode has been in use now for several hours daily for the past five weeks, and there is neither any fracture nor any sign of the pitting out of the glass as formerly. This hard glass is less liable than the soft sealing-in glass to be damaged by the disruptive action of the current, and the chilling process has the effect of toughening the skin of the glass as well as of perfecting the seal between the glass and the wire.

In connection with the same research, a large number of small vacuum discharge tubes were required. In most of these tubes, the electrical conducting wire has been sealed in by the Burnside process, and in every case the result has been entirely satisfactory. The spectral lines under observation are of rather low intensity, and, in consequence, exposures of four or five hours' duration are required to give a good photographic presentment. Generally, each tube has been used for two photographs. Thus the discharge has been passed in one direction for four hours or more, continuously, and then in the opposite direction, for a similar continuous period of four or five hours. In many cases, during the process of exhaustion, the tubes have been strongly heated by means of a bunsen burner; during some of the exposures, when the vacuum has been high, the tube has become very hot; in some cases the discharge has fractured the glass near the discharge end of the kathode; but in no single case has cracking occurred at the seal, nor has there been any sign of leakage. Considering the large number of tubes used, I think these facts afford striking evidence of the trustworthiness of the seal.

The essential part of Mr. Burnside's process of sealing consists of the repeated immersion of the leading-in wire and the glass surrounding it, in a bath of oil, fat, or wax. If a wire is to be led into a tube, the tube should be drawn down until the bore is just large enough to admit the wire. The conductor having been inserted, the glass around it is strongly heated in the blow-pipe flame until perfect cohesion has taken place between the metal and the glass. The wire should then be drawn out slightly, carrying the adhering glass with it, and this glass heated again. This may be repeated until a "neck" of glass about two or three millimetres long, and having the end well rounded, is formed around the wire. The seal is then withdrawn from the flame, and, when the red glow has entirely disappeared, the end of the tube carrying the wire is cooled by several immersions in the oil. This may best be done by bringing the bath containing the oil—a short, wide test-tube, say—up round the seal. Each immersion should last about two or three seconds. The depth of immersion is increased with each successive dip, until the seal is completely cooled out. In the case of vacuum tubes where the electrode requires a small inner support tube, the conducting wire can first be fused into the support tube, leaving a fairly long thick neck of glass in contact with the wire. This support is then well fused into the bulb of the vacuum tube in the usual way, and, finally, the seal is cooled out as described above. Not only does this cooling process render perfect the seal between the metal and the glass, but it also improves the junction of the glass of the inner tube with that of the outer. The leading-in wire of one of the vacuum tubes, immediately after being cooled out in oil, has been suddenly heated in the blow-pipe flame until it was at a bright red heat up to within about 1 mm. from the glass, without the seal being affected.

Compared with previous methods of sealing in electrodes, where a special "flux" glass had to be used, where care had to be taken to prevent the ordinary glass of the tubes from coming directly into contact with the metal, and where, unless special precautions as to annealing were observed, fractures frequently ensued, the present method is much simpler and easier, and more effective. It also enables us to make discharge tubes of Jena or other hard combustion glass. This was formerly quite impossible on account of the fact that no "flux" was known which was suitable for sealing wires through glass of this nature.

Mr. Burnside recommends that sperm oil be used, and that it be heated slightly before the glass is immersed in it. For the above work, I used the ordinary machine oil from the workshop—simply because it was most readily obtainable—and used it at room temperature. In cases where the position of the seal prevents its being conveniently immersed in a bath of oil, the process may be effected by bringing vertically upwards a piece of fat or wax cut to a suitable size and shape, and pressing it against the hot seal.

It may be mentioned also, that not only can platinum be sealed directly through Jena or other hard resistance glasses, and through fused quartz, but that perfect seals may be made between the more easily oxidisable metals, such as copper or iron, as well as platinum, and glasses having comparatively low fusion points, *e.g.* lead glass and German glass, or any glass of this nature. For large currents the conductor should be tubular, because it can be more effectively cooled out by repeated immersions than would be the case if a solid conductor of the same cross-sectional area were employed.

The cases to which the process is applicable in scientific work are obvious and numerous, and it is needless to specify them. In view of the number of applications of a commercial and industrial value, as *e.g.* in the manufacture of incandescent electric lamps, mercury-vapour lamps, etc., the process has been protected by patent in Great Britain and abroad; but I understand that this protection is not intended to restrict in any way its use in research laboratories or its application to any purposes of a purely scientific and unremunerative nature. F. F. S. BRYSON.

Natural Philosophy Institute, University of Glasgow, May 24.

Eryonicus-Polycheles.

IN a recent publication on the Crustacea of Ireland, "Decapoda Reptantia of Ireland," Part I., by C. M. Selbie (Fisheries, Ireland, Sci. Invest., 1914, I. (1914)), the question of whether the peculiar forms known as Eryonicus are larvæ of the crayfish-like deep-sea crustaceans Polycheles is answered to the effect that they are independent animals constituting a genus related to Polycheles.

As these animals since the days of the *Challenger* Expedition have enjoyed a special interest as the modern survivors of a group almost until then believed to be confined to Jurassic and Cretaceous times, I thought it might possibly interest some of your zoologist readers to learn about some of the results obtained through the study of the material collected in the North Atlantic by the *Michael Sars* in 1910 during the cruise undertaken by the late Sir John Murray and Dr. Johan Hjort.

To begin with, it must be mentioned that the best specific characters both in Polycheles and Eryonicus are derived from the arrangement of the spines on the carapace. Now a peculiar correspondence is observed in several species of the two "genera," making it possible to "pair" several of the Eryonicus species each with one of the Polycheles species, as will be seen from the following formula representing the position of spines in the median line of the carapace. In these formulæ, 1 and 2 denote single and double *pointed* spines, while 3 denotes a single *blunt* spine, and *c* the position of the cervical groove, the rostral spines being to the left:—

E. faxoni, Bouvier	2.1.2.1.3.*c*.2.2.3.2	*a*
P. sculptus, Smith	2.1.2.1. *c*.2.2. 2	*a*
E. coecus, Faxon	2.1.2.1.1[1].*c*.2.2.1[1].2	*b*
P. sculptus pacificus, Faxon	2.1.2.1. *c*.2.2. 2	*b*

The two species *a* live in the Atlantic, the species *b* in the Pacific. The only difference between the two pairs consists in *b* having a spine on the cardiac area on each side, this spine being absent in all specimens of *a* examined by Mr. Selbie and myself:—

E. hibernicus, Selbie... ...	2.1.1.2.3.1.*c*.2.2.3.2	*c*
P. nanus, Smith...	2.1.1.2. 1.*c*.2.2. 2	*c*
E. spinulosus, Faxon ...	2.1.1.1.2.1[1].1[1].*c*.2.2.1[1].2	*d*
P. tanneri, Faxon	2.1.1.1.2. *c*.2.2. 2	*d*
E. kempi, Selbie...	1.1.1.1.2.1. *c*.2.2.3.2	*e*
P. typhlops, Heller	1.1.1.1.2.(2)*c*.(2).(2). 2	*e*

The figures within brackets in the formula for *P. typhlops* denote that these spines in some of Mr. Selbie's specimens were of reduced size, single, or wholly rudimentary. It will be noted that the spines known or supposed to be blunt have no equivalent in the corresponding Polycheles.

[1] These spines are represented by Faxon as being pointed. I believe from analogy with all the Irish and *Michael Sars* specimens that they are in fact blunt.

Now, I ask, is it possible to explain the above correspondences as mere accident, or are they not to be taken as evidence of the Eryonicus species being in fact larval Polycheles?

One of the commonest objections to this theory is the giant size presented by some of the Eryonicus-specimens compared with the smaller Polycheles-individuals, though this need not signify much. Like so many other plankton animals, the Eryonicus are of a nearly jellyfish-like consistency, and it may as well be conceived that an Eryonicus can shrink into a small Polycheles, as that the Leptocephali, when turning into "montée," lose about 78 per cent. in weight (in dry matter they lose over 32 per cent.), according to Dr. Johs. Schmidt, the Danish specialist on eels.

If Eryonicus were adult animals, it would be rather remarkable that not a single egg-bearing female has been found among the fifty-nine specimens known to have been captured (Mr. Selbie, *op. cit.*, mentions thirty-five specimens, and the *Michael Sars* got twenty-four). It cannot matter much that secondary male sexual characters in different stages of development have been found in a few of the largest specimens.

Finally, it must be mentioned that one is at a loss where to seek the larvæ of Polycheles, which do not seem to be very rare animals (the Irish research steamer *Helga*, for instance, obtained thirty-two specimens) if these larvæ are not represented by Eryonicus.

For literature and details of the species in question, see Mr. Selbie's paper quoted above.

OSCAR SUND.

Bureau of Fisheries, Bergen, Norway, May 8.

The Age of the Earth.

IN NATURE of May 6, Mr. C. E. Stromeyer states that two conclusions in my letter published in your issue of April 22 are not correct; he claims, first, that the amount of energy lost by the earth is not compensated by the heat received from the sun; secondly, that meteoric bombardment of the sun has been left out of account as a source of energy.

As to the first point, the amount of energy lost in consequence of the temperature gradient in the earth's crust is of the order $1{\cdot}33 \times 10^{-6} \frac{\text{cal}}{\text{cm.}^2\text{sec.}}$. As this is 6000 times less than the total amount radiated, no useful purpose would be served by taking it into account.

As regards the second point, any heat due to meteoric bombardment up to date has been taken into account, as the sun's mass as it is known to-day was inserted in the calculation.

Perhaps the purport of my letter was not as clear as I could have wished. It was not so much my intention to weigh the evidence for or against an age of some twenty million years, as to emphasise the point that neither radio-activity nor any other known cause will account for a longer period. I have lately had the advantage of discussing the subject with Prof. Strutt, and must admit that the conclusions he has drawn from the helium contained in rocks appear unanswerable.

It would seem, therefore, that the origin of the sun's heat cannot be referred to any known cause.

Farnborough, May 15. F. A. LINDEMANN.

Modern Substitutes for Butter.

THE issue of NATURE dated April 8 contains an article relating to "Modern Substitutes for Butter," which gives a highly interesting impression of the technical and scientific state to which the margarine industry has developed in recent years.

Towards the end of the article, the author deals with the influence of vitamines, and indicates that, while these substances are present in butter, they would not be met with in margarine.

This characteristic would meet the case as regards certain butter and margarine products, but by far the largest quantities of butter now on the market are made from pasteurised cream, and the pasteurisation would no doubt have reduced the original quantities of vitamines very considerably.

On the other hand, large quantities of margarine contain, among other fats, cold-pressed oils (such as ground-nut oil) which, like the better grades of olive oil, do not undergo any refining process whatever, and would therefore lend to the margarine their original content of vitamines.

If vitamines are produced in the lactic acid fermentation of milk, an abundance of these precious substances would be imparted to both butter and margarine, as in buttermaking the ripening takes place after the cream has been pasteurised, and in the manufacture of margarine the ripened skim milk is churned with the fat after the latter has been refined. Hence in both cases the vitamines produced in the fermentation process are not subsequently subjected to any harmful treatment.

It therefore appears that, so far as the presence or absence of vitamines is concerned, margarine would rank as equal to butter. There are, in fact, qualities of margarine on the market which contain a small proportion of fresh egg yolk, and such qualities would doubtless be of high standing as regards vitamines.

S. H. B.

So little is at present known about vitamines that "S. H. B." may well be correct in assuming their presence in cold-pressed oils, in ripened skim milk, and in fresh egg yolk. Even hot-pressed oils have probably not been subjected to such a temperature as to kill the vitamines.

On the other hand, if the present writer's memory is not at fault, the work of American investigators has shown that of several oils investigated, butter fat alone contained vitamines. There is also evidence to indicate that vitamines are closely associated with lipoids, and it is doubtful whether they would be formed during lactic fermentation. It is evident should vitamines be present in nut oils as suggested, that nuts might form a valuable preventative of beriberi, or scurvy; the writer is unaware if this has been tested in practice.

As stated in the original article, probably sufficient vitamines are present in the rest of the dietary to enable them to be dispensed with in the fat.

THE WRITER OF THE ARTICLE.

May 20.

THE EXTINCTEUR AND ITS LIMITATIONS.

THE portable chemical fire-extinguisher, better known as extincteur, has been much before the public of late. Leaving aside the whole of those unfortunate appliances that belong to the dry powder class and the glass hand grenade type, which are entirely untrustworthy, the portable chemical fire-extinguisher in modern practice may be looked upon as a cylinder of from 2 to 3 gallons' capacity, containing water, with the addition of some substance which may, or may not, add to the efficiency of the extinguishing power of the water discharged.

There are, of course, one or two other forms of portable chemical liquid fire-extinguishers, *i.e.*, certain forms of less than a gallon capacity containing carbon tetrachloride or some combination thereof, intended for use on small petrol fires, and where the capacity is sufficient, say, from 2 quarts to 1 gallon, and the chemical is discharged automatically by some capsule of compressed air or the like, effective results are obtained from such appliances on small spirit fires. Where, however, the appliance only has the capacity of a pint or quart of carbon tetrachloride or some combination thereof, and has to be applied by manual action, the limit of effectiveness is certainly very small, a quart of chemical applied, say, by a double action squirt being able to deal at the most with a 2 gallon tin of petrol spilt over a motor-car or in some vessel of no great area. A weak spot in the use of carbon tetrachloride and its combinations, by the bye, is the fumes it gives off when in contact with fire. For this reason its use in enclosed spaces should in any case be avoided, and people suffering from liver complaint should in any case keep clear of this chemical when used on fires.

But to revert to the ordinary portable chemical liquid extinguisher of 2 to 3 gallons' capacity, as seen in many public buildings, and thus considered by the general public as something acceptable for every-day purposes. We are desirous of warning the public as to unsuitable purchases of such appliances. To begin with, in a very general way a portable liquid chemical fire-extinguisher is not the alpha and omega of first-aid fire-extinguishing, although there is no doubt that these appliances as such are popular. They look so bright and neat. Their presence advertises the owner's forethought. If finished on copper they are quite ornamental.

For the ordinary householder and for the ordinary business establishment where fire appliances are not under constant inspection, we would, however, rather pin our faith in the ordinary bucket of water energetically applied, and the ordinary miniature manual hand-pump or corridor engine. A few dozen buckets and a couple of hand-pumps, involving together perhaps an expenditure of 5*l.* to 6*l.*, will work wonders in a quite substantial fire, whilst the same 6*l.* will only produce three or four 2-gallon extinguishers, which require, as a rule, practice to discharge properly and time to re-charge at intervals; they require also most careful maintenance, and at the best will give the user some 6 or 8 gallons of chemically prepared water as against, say, the 50 gallons of water immediately available for continuous application and rapidly replenished without intervals. A small stirrup hand-pump of the London type, by the bye, can be worked singlehanded to supply 4 to 5 gallons per minute at an effective range of 25 to 40 ft.

The whole principle of putting out a small fire is the cooling effect of water applied in fair bulk continuously and under pressure; and the cooling effect can be best obtained by a copious supply of water continuously applied in fair force and bulk from buckets and hand-pumps. The possibility of applying water in bulk continuously with a good cooling effect cannot be obtained from the ordinary householder's supply of extinguishers.

Of course, in public buildings where there are many extinguishers immediately at hand, where they are thoroughly maintained, and are handled by skilled or trained men, they are most useful. They are the most handy of water economising minor fire appliances in the hands of a professional fire brigade, although we observe the London brigade only used them in 577 instances last year, whilst they used buckets in 1248 cases. They are essential makeshifts for conditions where buckets and hand-pumps cannot be equally well stowed or applied, as, for instance, on trains, in small boats, or for other awkward places, as, for instance, on the aeroplane in flight, but, to repeat, the alpha and omega of fire extinguishing is not to be found in the extinguisher for the ordinary man in the street. His *vade mecum* should be the bucket and hand-pump, although they are less showy.

These observations, however, should not preclude the purchase, and, in fact, should not discourage the purchase of well-made mechanical portable liquid fire-extinguishers, where there is a probability of their being properly maintained and looked after, as, for instance, in public and semi-public buildings, in large industrial establishments, or estates having private fire brigades, etc., especially if their attempted application can be immediately followed by the application of a hydrant or fire engine. In such places, if of good make in the first instance, and regularly looked after, they are neither likely to burst and injure the operator nor are they likely to get clogged up and fail at the critical moment. The danger of bursting is no small danger, and has resulted in fatalities as well as many personal injuries, whilst in the large majority of establishments where these appliances are not properly looked after they will be found defective at the time they are to be used.

Thus at the initial stage of purchase, some standard as to safety for extinguishers is essential to limit the risk of careless users. It is very much to the credit of the British Fire Prevention Committee, to whose work we have had frequent occasion to refer, that it has for some years been pressing towards obtaining a sound standard of manufacture in chemical fire-extinguishers, and that it has further succeeded in getting these standards adopted as necessary standards by the Government and other principal purchasers at home and in the colonies.

One of the first results of the Committee's propaganda in 1911–12 was that the fire insurance companies early in 1913 adopted an American specification which had been long in force in the United States, and started listing extinguishers that complied with this form. The American model, however, being insufficient for British conditions, the British Fire Prevention Committee, which had been making exhaustive tests both with new appliances and appliances in actual use, issued its own provisional specification later in that year, which form was immediately adopted by several authorities of importance in their purchases. Extinguisher construction accordingly commenced to improve.

Next, the Fire Prevention Committee suggested some form of conference with the Government departments on the matter, so that the Government departments might be specifying either on the committee's provisional specification or some similar—preferably stronger—specification. The result of this conference has been that, in turn, H.M. Office of Works last summer, the Metropolitan Police last autumn, the Board of Trade this March, and other departments have either issued their own specifications, which are now practically identical, or have adopted the improved form of the British Fire Prevention Committee's specification of January 1, known as the 1915 standard. The only corporations which still keep to the lower standard are the insurance companies, but no doubt they will also come into line as time goes on, whilst in the meantime they benefit from the fact that the more responsible makers are now all making their appliances to either the Fire Prevention Committee's 1915 specification or to those of the Government departments named. The recent War Office contracts, for instance, are all for extinguishers to the Office of Works' specification, whilst half-a-dozen other departments are specifying their war emergency supplies to the Committee's schedule.

A point has, of course, been made by the traders that the existence of several specifications makes it difficult for makers to keep suitable stocks, but this is not the case in actuality, inasmuch as it will be found that any maker who will stock cylindrical extinguishers made to the 1915 specification will meet the requirements of either one of the authorities and the committee.

All this, of course, touches the great corporations, the great public authorities, and the public when using establishments controlled by public authorities, be they theatres, factories, or the like. The misfortune, however, is that the general public, the householder, the ordinary estate-owner, the ordinary motor-car owner, etc., are still subject to the cheap-jack extinguisher and the specious tout who sells nothing more than a dangerous "tin can" at an exorbitant price—a can which probably costs somewhere around 10*s.* to manufacture, and for which he asks anything he can get—frequently as much as 2*l.* to 3*l.*

It is an open secret that the best-made chemical fire-extinguishers can be produced in large quantities and sold according to external finish, and after allowing for a fair profit, from, say, 17*s.* to 20*s.*, to comply with the specifications named, and they should thus be obtainable in lesser quantities of handsome finish at 25*s.* or less. The whole myth of purchasing extinguishers at prices varying from 2*l.* to 3*l.*, holding 2 gallons of liquid, gaudily furbished, is bad enough when the appliances are made to the best of specifications, but that they should be sold at these ridiculous prices when they are of the distinctly dangerous tin-can type, liable to burst easily, is very near fraud.

It is to be hoped that the British Fire Prevention Committee will persevere in its propaganda and obtain legislation after the war is over, making it a penal offence to construct an extinguisher unless there are certain constructional safeguards to be settled from time to time by the Secretary of State as mechanical science advances. Good progress has already been made in this direction, and but for the war, the protection of the public against fraudulent fire appliances might have already been achieved.

To our readers, however, this article should serve as one of warning to insist on a written warranty before payment for any extinguishers purchased, that it complies either with the British Fire Prevention Committee's specification, or with those of the Board of Trade, H.M. Office of Works, or the Metropolitan Police. Further, for the best finished article they should not pay more than 25*s.* to 30*s.* when constructed to either of these specifications, but if in doubt as to the machine offered or the possibility of regularly testing and re-charging it, let them keep to the old bucket of water and hand-pump. They at least are trustworthy, and the most suitable for ordinary conditions.

RESEARCH IN AERODYNAMICS.[1]

THE work of the Aerodynamical Laboratory at Koutchino is less affected by the necessity for technical work than any other of the European laboratories. It is for this reason, in all probability, that the latest bulletin makes a refreshing change from the publications of Eiffel and the Advisory Committee for Aeronautics.

The production of miniature whirlwinds forms the subject of one series of experiments, and the results are illustrated by some very interesting photographs. Rotations, as apart from eddies, are of frequent occurrence in nature; they may be seen in the autumn by the movement of leaves, due to a wind over open ground. Similar movements of air are found on the floor of the room below the intake of a wind channel, and the phenomenon indicates how little we really know of the motion of real fluids.

Perhaps the most interesting papers in the bulletin are two relating to the principle of dynamical similarity as applied to viscous fluids. Experiments with the same object were made by Osborne Reynolds, and recently Messrs. Stanton and Pannell have established the practical utility of the theory in the case of air, water, and oil flowing through pipes.

One of the two papers above mentioned deals with experiments on the surface friction of discs in air and water, the motion being one of rotation in their own plane. The agreement between theory and practice is complete. The second paper relates to the whole of the published information on the resistance of spheres in air and water, the results being very discordant amongst themselves. The conclusion is drawn that the conditions of the theory of dynamical similarity cannot in this case be satisfied experimentally with the necessary degree of exactitude. The results of the two papers are illustrated by Figs. 1 and 2. The first relates to the friction of discs, and in carrying out these experiments variations were made in three quantities of primary importance, the diameter and speed of rotation of the disc and the

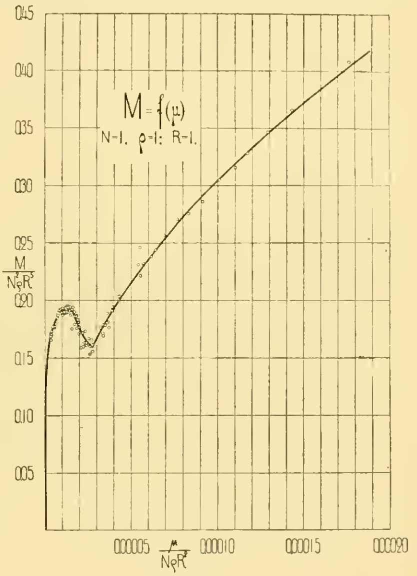

Fig. 1.

viscosity of the fluid. The ratio of the greatest diameter to the least was 10 : 1, the ratio of the extreme speeds 2 : 1, and the ratio of the kinematic viscosities 13 : 1. The theory of dynamical similarity indicates that any one of these changes can be predicted from the effect of changes in either of the others, and the practical proof of this is the fact that the whole of the experimental results can be collected on a single curve as in Fig. 1. As the range of variation included a region of critical flow, as indicated by the dip in the curve, the practical agreement is a delicate test of the exactness with which the experimental conditions complied with the conditions of geometrical similarity.

[1] Bulletin de l'Institut Aérodynamique de Koutchino. Pp. 296. Fascicule v. (Moscow: I. N Kouchnéreff and Co., 1914.)

The reverse picture is shown in Fig. 2. The principle of dynamical similarity applies as rigidly to the resistance of spheres as to the surface friction of discs, but the experimental results vary very widely over almost the whole of the experimental range. An interesting contribution on the reasons for such large experimental discrepancies is made by Prof. Prandtl, who showed that a wire of small diameter put round a sphere in an appropriate place had the somewhat surprising effect of reducing the resistance to about one-third of that of the smooth sphere. It was further shown that a gauze screen introduced into the air current immediately in front of the sphere had a similar effect. The conclusion appears to be justified that the flow of air round a sphere is so very sensitive that small departures from strict geometrical similarity and from the condition of uniform relative motion are sufficient to account for the large experimental variations.

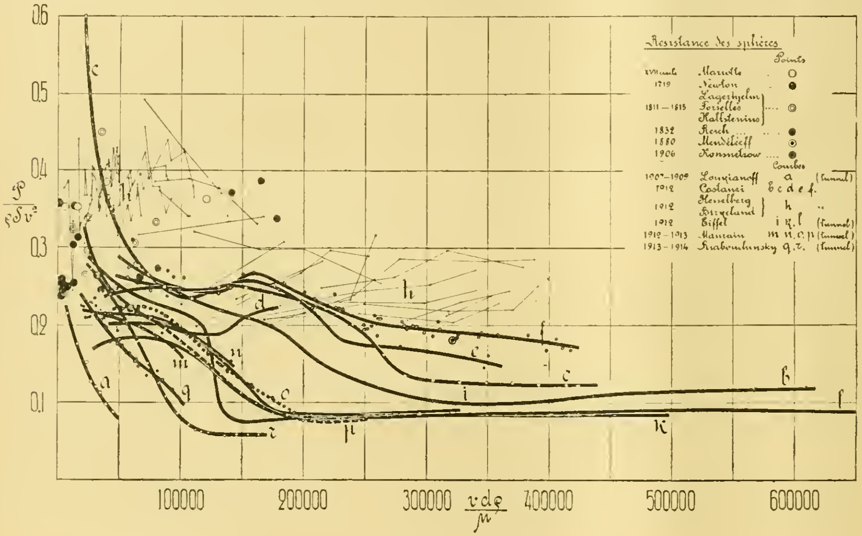

FIG. 2.

Further experiments are needed to clear up the position, but, obviously, no investigation can alter the fact that the resistance of a sphere must always be difficult to predict, except in very favourable circumstances. The possibility at least exists that the rough surface of a golf-ball has a very close relation to the instability of flow referred to, the advantage of the roughened surface being so great as to render it obvious in the direct test on the golf links.

It is fortunate for the future of aeronautics that similar troubles do not occur in connection with the important parts of an aeroplane, though an approach to such sensitivity has been found in the case of the fluid motion round certain struts.

DR. HUGO MÜLLER, F.R.S.

THE death of Hugo Müller will be greatly deplored by all who knew him—he was one of those few men who only make friends and at once inspire regard in all who are brought into contact with them. He died suddenly, at his country home, at Camberley, Surrey, in the early hours of Sunday, May 23, in his eighty-second year. Though very deeply distressed by the war, he enjoyed his usual good health to the last; in fact, he was in his garden until late in the evening on the previous Saturday and had worked in the Davy-Faraday laboratory up till Friday afternoon. He was buried at Brookwood Cemetery on Thursday last alongside his old friend Dr. Atkinson.

He was born at Tirschenreuth in the Oberpfalz. He was educated as a chemist at Leipzig, at Göttingen under Wöhler and at Munich under Liebig; but he also took special interest in mineralogy and was an ardent collector of minerals in his early days. It is clear that he was a precocious worker, as he described the geognostic-mineralogical features of his home district in 1852 in the *Regensburg Corresp. Blatt.*

He came to this country sixty years ago, on the recommendation of Liebig, as assistant to Dr. Warren de la Rue. Their first joint work involved the examination of Burmese naphtha at a time when very little was known of the petroleums. But they took up a variety of subjects and one of their most valuable contributions was the well-known chloride-of-silver-zinc constant battery which they devised. Dr. Müller also worked with

Stenhouse. His most noteworthy early discovery perhaps is that involved in the use of iodine as a catalyst in chlorinating. He was an intimate friend of Kekulé when the latter was in London.

A man of great personal charm of manner, of sympathetic nature and very versatile, he inspired confidence not only by the breadth and accuracy of his knowledge but also by his calm and clear judgment. His worth was soon recognised, so that he was consulted constantly by the firm of De la Rue and Co. long before he was induced to give up science and enter upon an industrial career in its service; ultimately he became a partner in the firm and remained in it until 1902 The Stamp department was his chief charge; in this he found full opportunity for the exercise of his scientific ability and great technical skill as well as of his artistic gifts. He was elected a fellow of the Royal Society in 1866. He joined the Chemical Society in 1859; he was its foreign secretary from 1869 to 1885 and president in 1885-87. He was a Ph.D. of Göttingen, an LL.D. of St. Andrews and a D.Sc. of Manchester. He became naturalised thirty-seven years ago, on his marriage to an English lady. He had two daughters, one of whom and his wife survive him.

When the Lawes Agricultural Trust was constituted by his old friend Sir John Lawes twenty-six years ago, he was appointed a representative of the Royal Society on the Committee and became the treasurer; he held the office until the present year, when he retired, in spite of the urgent requests of his colleagues that he would not sever the connection; but he thought that German residents in this country, whether naturalised or not, were so seriously affected by the outbreak of the war that it was not desirable that a person in his position should be a member of or take part in the affairs of any public concern or enterprise. He consistently remained aloof from everything.

Although his time was fully occupied by his business avocations while in the firm of De la Rue and Co., he never lost his interest in his science; since his retirement he worked regularly in the Davy-Faraday laboratory of the Royal Institution. The work he did, which has been published by the Chemical Society, is remarkable as proof of his exceptional skill as a manipulator and of special value to science. Only recently he completed the investigation of the peculiar bloom which appears on the leaf and flower-stalk of a number of species of primula; he made the striking discovery that this consists of flavone, the parent substance of the great group of yellow colouring matters present in plants, a substance only prepared in the laboratory previously.

Dr. Müller was also a noted horticulturist and botanist; he was long an active member of the scientific committee of the Royal Horticultural Society. Beginning thirty years ago with a sandy waste at Camberley, Surrey, he developed one of the most remarkable and beautiful gardens in the country. His knowledge of plants was quite exceptional, as it had long been his habit to grow them in order that he might know them; his garden, therefore, was always of special interest.

A man of large and noble mind, he was torn with distress by the outbreak of the war, which he looked upon as a downfall of civilisation; he deplored his having lived to see it and there is little doubt that his end was greatly hastened by recent events.

DR. M. W. CROFTON, F.R.S.

DR. M. W. CROFTON, whose death was recently announced in NATURE, was born in Dublin in the year 1826, the son of Rev. William Crofton, of Sligo, a clergyman of the Established Church. Together with his brother Henry, who was two years his junior, he entered Trinity College, Dublin, in the year 1843 under the tutorship of Dr. Graves, who afterwards became professor of mathematics in the college, and later Bishop of Limerick. Diligent students both brothers must have been, for at the moderatorship examination in 1847 Morgan, who had captured on the way all the undergraduate prizes open to him, came out first of his class in mathematics, while Henry headed the list in classics, a double event rare, if not unique, in the history of the College.

When the Queen's University of Ireland was established, Dr. Crofton was appointed professor of natural philosophy at Queen's College, Galway, a position which he resigned in 1853 after three years' occupation. He was afterwards professor of mathematics and mechanics in the Royal Military Academy, Woolwich, from 1870 until 1884, and on his resignation was appointed to a fellowship of the Royal University of Ireland, retaining that position until 1895. Dr. Crofton published a treatise on the "Elements of Applied Mechanics" (London, 1881), and contributed several papers on geometry and mechanics to various journals, but his chief interest was in the mathematical theory of probability. There is a paper of his in the *Phil. Trans.* of the year 1868 "on the theory of local probability applied to random straight lines," and another in the *Phil. Trans.* of 1869 "on the proof of the laws of errors of observations." He wrote also the chapter on mean value and probability in Williamson's "Integral Calculus," and the article, "Probability," in the ninth edition of the Encyclopædia Britannica.

Dr. Crofton was elected a Fellow of the Royal Society in 1868. S. B. KELLEHER.

NOTES.

WE notice with much regret the announcement of the death, on May 31, in his eighty-first year, of Sir A. H. Church, K.C.V.O., F.R.S., formerly professor of chemistry in the Royal Academy of Arts.

MEN of science view with especial satisfaction the appointment of Admiral Sir Henry Jackson, K.C.B., F.R.S., as First Sea Lord of the Admiralty. So far as we are aware no precedent exists for the nomination of a fellow of the Royal Society as First Sea Lord of the Admiralty. Born on January 21, 1855, Sir Henry entered the Navy at thirteen, became Lieutenant of the *Active* during the Zulu war of 1878–9, and was promoted Captain in 1896. He afterwards became Assistant-Director of Torpedoes (1902), Controller of the Navy (1905), and Chief of the War Staff at the Admiralty (1913–14). In science Sir Henry Jackson's work refers chiefly to electrical physics. In the 'nineties of last century he was among the first to engage in the practical application of electric waves transmission; in other words, wireless telegraphy. He early made the acquaintance of Mr. Marconi, the two collaborating in important researches. In 1895 Sir Henry began systematic experiments and trials under sea-going conditions (inclusive of the use of balloons and kites), with the view of utilising the effect of Hertzian oscillations for naval signalling purposes. The results were embodied in a paper read before the Royal Society, entitled "On Some Phenomena Affecting the Transmission of Electric Waves over the Surface of the Sea and Earth." From 1905–6 he was A.D.C. to King Edward VII.; in 1906 he was made K.C.V.O., and, in 1910, K.C.B. The Royal Society elected him into its fellowship in 1901. A member of the Institution of Electrical Engineers, and an associate of the Institution of Naval Architects, Sir Henry also serves on the general board of the National Physical Laboratory, and has consistently promoted its interests in official quarters. It may be of interest to give the names of those fellows on the Royal Society's current list who either are naval men or are engaged on Admiralty service. They comprise Admiral Sir A. M. Field, late Hydrographer; Capt. T. H. Tizard, late Assistant-Hydrographer; Sir Henry J. Oram, Engineer Vice-Admiral, Engineer-in-Chief of the Fleet; Capt. E. W. Creak, C.B.; Sir Philip Watts, late Director of Naval Construction; Mr. R. E. Froude, Superintendent of the Admiralty Experimental Works at Gosport; Sir J. A. Ewing, Director of Naval Education; Sir John Thornycroft; and the Hon. Sir Charles Parsons.

WE learn from the *Scientific American* that Mr. Walter G. Davis, director of the Argentine Meteorological Service, recently retired on a pension, and was succeeded by Señor Martin Gil, described in the Argentine newspapers as a wealthy amateur meteorologist and astronomer, much interested in long-range weather prediction.

A WAR Exhibitions has been organised to assist the funds of the Belgian Red Cross Anglo-Belgian Committee, whose patroness is the Queen of the Belgians. The exhibition is designed to present an idea of the extent to which science and industry are being utilised in every branch of the present gigantic struggle. The exhibition comprises seven sections, which include, with others, armament and ammunition in the making, Red Cross work, science and industry applied to war, food and hygiene, and a maritime and aerial section. The exhibition will be held at Prince's Skating Club, Knightsbridge, London, from June to October.

DURING a thunderstorm near Gibraltar on May 25 a cloud is said to have belched forth millions of small frogs which had apparently been drawn up from a lake twenty miles away. Such "showers of frogs," when satisfactorily authenticated, are to be ranked along with showers of sticklebacks, herring, and even larger fishes. Some of these showers are well vouched for, and admit of physical interpretation. In an eddy of a whirlwind there is sometimes draught strong enough to suck up dust and leaves and sheaves, or water and fishes and frogs. The whirling column is borne on by the wind and may transport its burden for many miles until the rotational energy is expended and the little tornado is over. It must be carefully noted, however, that the sudden appearance of multitudes of small frogs often implies nothing more than the usual migration of the young frogs from their birthplace in the pond to their summer quarters in the fields. Similarly, as Gosse pointed out long ago, alleged "snail showers" are apt to disappear under scrutiny, and "a torrent of periwinkles" turns out to be a migration of *Helix virgata* or the like. In his "Romance of Natural History" Gosse inquired in a fair-minded way into the various kinds of animal "showers," and came to the conclusion that some of the records were worthy of credence as regards frogs, toads, and fishes. It is probable enough, then, that the Gibraltar shower was genuine.

A REMARKABLE discovery of flint implements has been made recently at Highfield, Southampton, and a large selection of them is now displayed in two new cases in the prehistoric section of the County Historical and Antiquarian Museum at Tudor House. The spot where they were found is apparently the site of the workshop or cache of a Palæolithic master-craftsman in flint, and great numbers of implements in various stages of fashioning were brought to light on a limited area. The series shown covers the whole technique of manufacture, from the roughly-shaped-out slabs of table flint to beautifully chipped and completed implements, with their edges still unabraded. It includes blanks or shaped forms of flint cut with astonishing precision, portions of implements broken in process of making, chips, etc. Some of the smaller implements vie in beauty of workmanship with the fine products of Neolithic culture, and are also of shapes generally associated with the later Stone Age, though their gravel patina is indisputable proof that they came from the river drift, and so are of Palæolithic origin. Series of both large and small implements, the latter including various forms of scrapers, arrow-points, etc., are shown in their different stages of making, so that the processes of manufacture become clear to the student. It is worthy of recording that the surface soil of the site yielded some interesting Neolithic implements, which are also shown.

STONEHENGE, the most remarkable of our national prehistoric monuments, is included in the Amesbury Abbey estate, Wiltshire, which is to be sold by auction in September. Much information about this notable structure and its significance will be found in Lady Antrobus's "Sentimental and Practical Guide to Amesbury and Stonehenge" and Sir Norman Lockyer's "Stonehenge and other British Stone Monuments Astronomically Considered." The first British author who is considered to make unmistakable mention of Stonehenge is Henry of Huntingdon (twelfth century). He refers to it as the second wonder in England, and calls it Stanenges. Geoffrey of Monmouth (A.D. 1138) wrote of it about the same time, as did also the Welsh historian, Giraldus Cambrensis. The outer circle of thirty upright stones has a diameter of about 100 ft. These stones formerly stood 14 ft. above the surface of the ground. Within this peristyle there was originally an inner structure of ten stones arranged in the shape of a horseshoe formed of five (but some think seven) huge trilithons, which rose progressively in height from north-east to south-west, the loftiest uprights being 25 ft. above the ground. About one-half of these uprights have fallen; during the operations connected with the raising of one of the uprights in 1901 numerous flint axe-heads and large stone hammers were found at a depth of from 2 ft. to 3 ft. 6 in. underground—all tending to prove the great antiquity of the monument. From his investigations of the orientation of Stonehenge, upon the assumption of the structure having been erected as a solar temple, Sir Norman Lockyer concluded that the date of its foundation was 1680 B.C.

We regret to learn of the death of Dr. Aksel S. Steen, director of the Norwegian Meteorological Institute, and fellow of the Norwegian Academy of Sciences. Dr. Steen was for many years assistant director of the Norwegian Institute, and he succeeded the veteran Prof. Möhn in the directorship in September, 1913. He contributed many papers to meteorological literature on the climate and weather of Norway, but he is perhaps best known for his comprehensive report on the observations made at the Norwegian station at Bossekop in connection with the international exploration of the polar regions during the years 1882–83, and for his report on the terrestrial magnetic results of the second Norwegian Arctic Expedition in the *Fram* in 1898–1902. The latter report was supplemented by an interesting discussion on the diurnal variation of terrestrial magnetism in the northern hemisphere. Dr. Steen's visit to England in 1904 as a member of the International Solar Commission which met at Cambridge in that year, is pleasantly remembered by those who met him on that occasion. He was born at Christiania in 1849, and died there on May 10.

In this country it is unfortunately so rare to find young men, equipped by a scientific training with the exact habit of mind essential to all historical studies, willing to turn their attention to art-history and museum-management, that the loss of such a promising recruit as Second-Lieutenant Percy Herman Charles Allen (3rd attached to 2nd Battalion East Lancashire Regiment), killed in action in France on May 9, is much to be deplored. Educated as a mathemathical exhibitioner of Christ's Hospital, and scholar of Caius College, Cambridge, Mr. Allen became for a time an assistant in the Victoria and Albert Museum, and in January, 1914, was appointed assistant keeper in the fine art department of the Ashmolean Museum, Oxford. His natural taste and exactitude of perception were beginning to find true scope in the complicated task of determining questions of states and copies amongst the early engravings forming part of the vast collections bequeathed by Francis Douce to the University. In a short time he did much valuable work. A remarkable memory and grasp of the nature of facts gave his judgment the sureness only acquired as a rule by long experience. It seemed safe to predict that his career, cut short at twenty-five years, showed promise of a future of much brilliance.

The late Captain S. A. Macmillan, attached to the 58th (Vaughan's) Rifles, Indian Army, whose death at the front has recently been reported, had been engaged for about a year on the work of the survey of the mammalian fauna of India, Burma, and Ceylon. This survey was started in 1911 by the Bombay Natural History Society with the object of carrying out, in conjunction with the British Museum (Natural History), a systematic study of the Indian mammal fauna. Early last year the society secured the services of Capt. Macmillan as a collector in Burma to work with another of their collectors, Mr. Guy Shortridge, who is now serving in France as an officer of the 29th Bengal Lancers. Capt. Macmillan had been on a rubber estate in Tenasserim, and was not only a keen hunter, but also possessed a local knowledge of languages, etc., which proved of great value to both collectors whilst in Burma. They were doing splendid work for the survey, and had made a very fine collection of mammals from Monywa and Kindat in Upper Chindwin and elsewhere in Burma when the war broke out, and abruptly put a stop to their efforts in this direction, the activities of both being transferred to the military. Before leaving India Mr. Shortridge and Capt. Macmillan exhibited their specimens at a meeting of the Bombay Natural History Society, the fine series of different squirrels particularly creating much interest. The Society has lost in Capt. Macmillan a keen worker of the highest efficiency, who promised to accomplish still more valuable work towards bringing the survey to a completion.

By the recent death of Prof. D. A. Louis, at fifty-eight years of age, the technical Press has lost one of its most gifted representatives. A Londoner by birth, he studied at the Royal School of Mines in the year 1876 and 1881, devoting most of his attention to chemistry, metallurgy, and physics. From 1882 to 1886 he was employed at Rothamsted on agricultural research, and there carried out important experiments for Sir John Lawes. His connection with mining and metallurgy is to be traced to an appointment he had in Colorado, where he gained practical experience in mining. From 1891 he practised as a consulting mining engineer and metallurgist in London, making periodical visits abroad to most of the European and American mining districts. In 1893 he became an assistant examiner in mining to the Board of Education, and in 1900 was appointed professor of mining at the Yorkshire College at Leeds. In 1907 he took a prominent part in the third International Petroleum Congress at Bucharest. In 1910 he was hon. secretary of the metallurgical section of the seventh International Congress of Applied Chemistry; and as a petroleum mining expert he visited Egypt, Russia, Galicia, and Rumania. As a journalist Prof. Louis had a marvellous gift of assimilating information rapidly; and his wide scientific knowledge was never at a loss. He was a constant contributor to many leading technical journals in this country, and frequently reported meetings of the British Association for the *Times*, the *Engineer*, etc. Prof. Louis was for many years foreign representative of the International Association of Journalists. He acted as hon. secretary for the congress which was held in this country in the year 1909, when his gifts as a linguist, his knowledge of foreign countries, and his geniality and *savoir faire* were invaluable. His loss is deeply felt by a large number of friends.

In an article entitled "Stricken Serbia" in the *Times* of May 28, a distressing picture is given of the ravages of typhoid, typhus, and relapsing fever in that country. The two last diseases, which accounted for some 15,000 of the sufferers, were traced to the Austrians who left their sick at Valievo. The conditions on the arrival of the various relief organisations were appalling; an observer speaks of "the mass of fever patients lying in all their filthy and verminous rags on the floors and under the beds of what are not hospitals but mere charnel-houses for the dying"! Nevertheless, in less than two months the diseases were got under, typhus being almost stamped out. This was accomplished by the energy of Colonel Hunter and Lieut.-Colonel Stammers and the devoted band of doctors and nurses acting under their direction. Six months of war had depleted the country of stores and provisions, and hospital stores and comforts had to be brought from England or Malta. Clearly the first need was to break the lines of communication between the troops and the rest of the country. Quarantine stations were established, all railway communication was suspended for fifteen days, all leave from the army was stopped, and soldiers on leave were recalled. The problem of typhus was comparatively simple, as this disease is spread by lice. Three weeks were given up to the disinfection of clothes, blankets, and linen; and hospitals and their contents were disinfected. Notification was enforced, and infectious patients were removed to isolation hospitals. The sanitary staff travelled from place to place in a special train and instructed the people what to do. Preventive inoculation especially against cholera was also resorted to, as this dread disease is very likely to break out under such conditions. The work was carried out by two hospital units, Lady Paget's and Lady Wimborne's, each with about fifty doctors, nurses, and orderlies, and by smaller contingents under Dr. Moon and Mrs. Hardy.

Mr. G. F. Chambers, whose death on May 24 at seventy-four years of age we regret to record, was a very voluminous writer on many subjects, legal, political, ecclesiastical, but the book which gives him the best scientific claim to remembrance was written when he was not yet twenty years of age. This was the "Handbook of Descriptive Astronomy." In 1861, though England then boasted a distinguished and zealous band of amateur astronomers, amongst whom were numbered men like Birt, Dawes, De la Rue, Green, and Webb, there was no literature to meet their special necessities. The first edition of Mr. Chambers's "Handbook," published in December, 1861, formed an admirable compendium of the results of astronomical science at that date in the departments which particularly appealed to the amateur observer. The success of the adventure was pronounced; other editions followed, and when the fourth and last edition was brought out, in 1889 and 1890, the book had expanded into three volumes, containing altogether more than 1600 pages. The speciality of the work lies in the number which it contains of useful catalogues, of auxiliary tables for the simple reductions of a private observatory, of descriptions of different forms of telescope mountings and houses adapted for small observatories, and so forth. Mr. Chambers, though he was himself the possessor of one of the small observatories for which he especially catered, did not contribute much to science by his own personal observations, but he was indefatigable in compiling useful or popular works on the subject. One work upon which he bestowed a great amount of labour, viz. his revision of Admiral Smyth's "Celestial Cycle," proved a failure, since his direct practical knowledge of double star astronomy was not sufficient to warrant him in undertaking so important a task; but his smaller and more popular astronomical books have met a cordial reception from the public. These are his "Pictorial Astronomy" and his "Stories" of the sun, stars, eclipses, weather, and comets. He was an original member of the British Astronomical Association, and served for many years as vice-president or on its council. In connection with this association, he took a great interest in eclipse expeditions, and spared no time or energy in ascertaining the best routes by which intending observers could travel to places within the shadow track.

The *Daily Telegraph* published a telegram "From our own correspondent at Copenhagen," on May 26, reporting that "A Danish surgeon and scientist of the highest reputation has succeeded in discovering what the German soldiers use to protect themselves against the asphyxiating gases which they employ against the enemy." The "discovery" is that the Germans make use of solutions of hyposulphite and bicarbonate of soda to moisten their respirators. The announcement reminds us, however, of the belated discovery of the lamented death of Queen Anne! The use of such solutions is well known to all workers with chlorine gas, and was mentioned in daily papers a day or two after the Germans commenced to discharge the gas upon our troops.

Dr. A. R. Friel describes, under the term "piantication," modifications of microbes induced by treating them one or more times with blood-serum, which are transmissible to, and cumulative in, their descendants. Thus organisms which previously almost completely resisted ingestion by leucocytes when "pianticated" are ingested in large numbers by leucocytes (South African Institute for Medical Research, January 26, 1915).

In the Proceedings of the National Academy of Sciences, Washington (vol. i., p. 256), Dr. C. D. Walcott announces the discovery of bacteria in one of the petrified algæ from pre-Cambrian rocks in Montana, to which reference was made in Nature last week (p. 354). They appear in the algal tissue as irregular chains of darkly stained cells from 0·95 to 1·3 microns in diameter, and are very suggestive of Micrococcus. It is not always possible to distinguish with certainty such fossils from purely mineral structures, but satisfactory traces of bacteria have already been detected in the fossilised remains both of animal and plant tissues in European Palæozoic rocks, and they are to be expected among the earliest organisms.

Through Mr. Bassett Digby, the geological department of the British Museum (Natural History) has lately obtained a well-preserved front horn of the woolly rhinoceros from the frozen earth of northern Siberia. The specimen measures nearly a metre in length, and, though partly cut as usual by the natives who found it, shows the backward curvature of its slender apex and the lateral compression of its characteristic sharp posterior border. The new horn has been mounted, with a hinder horn already in the museum, above one of the exhibited skulls of woolly rhinoceros from Siberia. It is thus possible to realise the unusually large proportions of the horns in this extinct species.

The question of the pollution of the air of our manufacturing towns has been a serious one for some time, and the report of the Air Pollution Advisory Board of the city of Manchester will prove a valuable document to those seeking to mitigate a serious evil. It appears that the domestic grate is the principal offender and that the modern factory with mechanical stokers is comparatively, if not absolutely, innocent. In many cases, however, the impurities are not due to indifferent stoking, and for these the electrostatic method of precipitation which has proved so successful in America may be recommended. An interesting account of the method and the results of its application will be found in the *Electrical Review* for May 14. Briefly, the polluted air passes between electrodes maintained at a difference of potential of 100,000 volts, and the particles of carbon, arsenic, potash, or chlorine are carried by the discharge to one of the electrodes. About five kilowatts are necessary to deal with about 30,000 cu. ft. of air per minute, so that the cost is slight. In many of the cases cited the value of the material recovered in a year exceeded the cost of installation and working of the apparatus.

The *Times* Engineering Supplement for May 28 touches on a point in works organisation to which too little attention has been given in this country, especially in the case of small- and medium-sized factories. Before the war, our industries suffered severely from German competition; this has been attributed in varying degrees to free trade, lack of technical education, and so forth. As the output of our factories must now be increased, our contemporary asks: Given perfect workmen and entire absence of alcohol, is the management of such a high order that the output is a maximum? Are the proprietors, or directors, so wholehearted in their patriotism that they lose no time? Are they so skilled in their respective spheres that they are able to guide their staff and workmen? In large firms the organisation is generally of a high order of efficiency, but it must be confessed that a large number of small firms work from hand-to-mouth in such a manner that output and delivery of orders to a stated time are quite problematic matters. Many of these smaller concerns are in the hands of a family, or financial men, who know nothing of the work being carried on, and whose sole object is to derive as large an income as possible with the minimum of effort. Such firms which are not producing a good average should be visited by skilled managers, and the real cause located. If lack of capital is the cause, the Government should assist; if incompetent management, the offenders should be removed; and if the cause is lack of plant which cannot be immediately rectified, the factory should be closed and the men drafted to a well-organised concern.

The director of the Geological Survey of the Union of South Africa asks us to announce that no annual report of the Survey will be issued for the year 1914. The announcement is made to spare the necessity of inquiries from the many scientific institutions, etc., which are on the complimentary list of the Survey.

Erratum.—In equation 2 on p. 359 of Nature of May 27, the symbol T should appear as a factor in the denominator of the fraction, and there should be a minus sign before *r* in the numerator. Both omissions were overlooked by the author in two proofs corrected by him.

OUR ASTRONOMICAL COLUMN.

Observations of Nebulæ at the Helwan Observatory.—Mr. H. Knox Shaw describes in Bulletin No. 15 of the Helwan Observatory the observations made with the Reynolds reflector up to the end of September of last year, this paper being a continuation of that published in Bulletin No. 9. This work is described as being somewhat of a reconnaissance to see which nebulæ would repay photographing with long exposures when the new Ritchey 30-in. mirror is mounted. The paper gives a list of the nebulæ observed, and also one of thirty-one new nebulæ confirmations of which have been made by second photographs in each case. Referring to N.G.C. 6729, the nebulæ attached to the variable star R. Coronæ, Aust., the author states that this nebula is certainly variable, and the question as to how its variability is connected with that of the star is being studied, and is promised as a separate paper.

Stars with Proper Motion Exceeding 0·50″ Annually.—Mr. Adriaan van Maanen contributes to the April number of the *Astrophysical Journal* (vol. xli., No. 3) a very useful list of stars with proper motion exceeding 0·50″ annually. This list is based on Porter's and Kobold's lists, which indicated proper motions greater than 0·50″ annually, on Bossert's catalogue of proper motions of 2641 stars, and on numerous other subsequently published notes on stars of large proper motion. The present list is made as far as possible homogeneous throughout, and deals with 533 stars. A column is given showing the spectra of the stars as determined by Mr. W. S. Adams or Miss Cannon. The positions in right ascension and declination are for the equinox 1900·0, and the proper motions are given for both amount and direction. Remarks regarding uncertainties in proper motions are added, and in the case of double stars, the number in Burnham's General Catalogue is given. Attention is directed to a list by Innes of proper-motion stars south of $-19°$; this appeared subsequent to the printing of the present paper, and Mr. van Maanen adds the numbers of Innes's list which should be included in his communication.

ORBITS OF VARIABLE RADIAL VELOCITY STARS.—In the April number of the Journal of the Royal Astronomical Society of Canada some reductions are given of the measures of the variable radial velocities of stars. The orbit of 136 Tauri, deduced by J. B. Cannon, is based on sixty plates taken at the Ottawa Dominion Observatory between November, 1911, and January, 1915. The paper gives a list of the observations. The spectrum of this star is of the A type, and the deduced period is 5·969 days. The same writer deals also with the orbit of ξ Andromedæ, a star of the K type spectrum, and utilises fifty-eight plates taken at the same observatory between September, 1913, and February, 1915. On the average about twelve lines were measured on each plate, and, generally speaking, the agreement was very fair. The final period derived was 17·767 days. In both of the above stars comparisons are made with the Lick Observatory results. The orbits of the spectroscopic components of 50 Draconis are discussed by W. E. Harper from the velocities of the ten plates secured at the Yerkes Observatory, and thirty-four taken at the Dominion Observatory. Both spectra were of the A type. The Yerkes and Ottawa observations both indicate a period of 4·120 days. The determination of the orbit of the spectroscopic binary, 1149 Groombridge, was also undertaken by the same writer using thirty spectrograms secured at Ottawa and three secured by Adams. The star is of the A5 type, and the spectrum has numerous lines well adapted for measurement. In the list of final elements derived the period is given as 9·944 days.

MANCHESTER ASTRONOMICAL SOCIETY.—No. 1 of the Journal of the Manchester Astronomical Society, for the session 1913–14, gives a brief account of the origin of the society and a statement as to its growth since its foundation in 1903. The object is for the association of amateur astronomers, for mutual help, their organisation in the work of astronomical observation, and the encouragement of a popular interest in astronomy. The society numbers at present 131 members, and its president is the Rev. A. L. Cortie, S.J. The journal gives excellent portraits of the present and past four presidents; and the address of the president on the origin of the sun and stars is printed and illustrated with three plates. A paper on Japanese and other magic mirrors is from the pen of the late Mr. T. Thorp, who was an original and active member of the society. Lunar photography, by Mr. William Porthouse; astronomy and æsthetics, by Mr. E. Denton Sherlock; and a remarkable solar prominence, by Mr. A. Buss, form the subjects of other papers printed in this issue.

CONSTITUENTS OF EXTRACTS DERIVED FROM ALBUMINOUS SUBSTANCES.

A JOINT meeting of the Society of Public Analysts and the Biochemical Society, which was held at the Chemical Society's Rooms on May 5, was devoted to the discussion of the methods adopted in estimating the nitrogenous constituents of extracts derived from albuminous substances, such as meat extracts. Mr. A. Chaston Chapman, the chairman, in opening the discussion, pointed out that from the technical point of view the purposes to be served by such analyses were, first, to indicate the general character of the process by which any particular extract had been prepared; secondly, to throw some light on the source of the extract and its genuineness or otherwise; and, finally, to furnish information as to the physiological properties of dietetic value. He then gave an outline of the existing methods of analysis, and emphasised their limitations; more particularly the practice of returning the "residual nitrogen" as "meat bases," using the factor 3·12 for the conversion was a source of uncertainty and confusion, especially as Hehner had suggested the use of the ordinary protein factor, 6·25, for the same purpose. The best plan was to return the actual nitrogen percentages.

Dr. F. Gowland Hopkins, dealing with the question of the food value of meat extracts and similar preparations, pointed out that the animal body dealt not with the intact proteins, or even with the albumoses and peptones, but with the free amino-acids which were the individual constituents of the protein molecules. The way in which these acids were grouped in the protein molecule was not of much consequence, but the effects produced by the individual amino-acids were of extreme importance. He described physiological experiments which he had made showing that when rats were given a diet including a complete amino-acid mixture corresponding with the proteins of an ordinary diet, the growth was almost exactly normal, but when arginine and histidine were removed from the mixture, growth ceased immediately, but was again resumed when the missing constituents were added. The removal of tryptophane produced similar results, and Osborne and Mendel had, in America, shown that cystine was similarly essential. It did not follow that this was the case with every amino-acid, and the question as to which of these were vitally necessary offered a large field for investigation. Experiment had shown that in the case of rats, the critical minimum for arginine lay somewhere between 2½ and 1 per cent. The functions of the individual amino-acids were not confined merely to flesh formation. Thus, for example, the effect of feeding animals on zein, which was deficient in both tryptophane and lysine, was not only to restrict growth, but to shorten the survival; the same was true with zein *plus* lysine, but with zein *plus* tryptophane the animal was able to maintain its weight for a long period, although it did not grow.

Dr. E. P. Cathcart said that observations at present available were so scanty that it could not be said with certainty that creatine and creatinine had a special niche in the organism. He did not think that any end would be gained by the separate estimation of these two substances. Mr. A. R. Tankard and Mr. E. Hinks dealt with questions of procedure, and Dr. Percival Hartley described his experience of Van Slyke's method of estimating amino-nitrogen; further remarks were made by Dr. Rideal, Prof. Barger, Dr. Harden, and Dr. S. Walpole.

MUSEUMS AND EDUCATION.

THE *Museums Journal* for May contains an interesting and suggestive article on the educational work of American museums, by the director of the Charleston Museum. It is abundantly clear from this that the functions of the museum in America are, so to speak, intensively cultivated. And nowhere is this more apparent than in the facts which he gives in regard to the co-operation which has grown up between the museums and the public schools. It is now the rule, he tells us, for children to be brought in batches by their teachers for regular instruction by the museum staff. This is given partly in the form of tours round the galleries, and partly by lectures given in class-rooms set apart for this purpose. Instruction is also provided for higher-grade scholars and for the teachers themselves.

In some places, as in Philadelphia, to obviate loss of time in taking large classes to the museum, it is now customary to send travelling exhibits from the museum to the schools.

Further efforts to utilise the museum as a means of education have resulted in the formation of children's museums, where collections of birds and beasts likely to interest children are arranged so as to convey some definite and easily assimilated ideas. as, for example, on the significance of animal coloration, or the shapes of animals.

The rapid increase of vocational and industrial training in the public schools of America, the author remarks, is already creating a demand for further assistance from museums, which they are meeting by lectures on the relation of natural resources to commerce and industry, and by exhibits illustrating processes of manufacture. It is probable that this is but the beginning of a phase of museum work which will ultimately occupy a large place in the activities of general museums and lead to the establishment of special industrial museums.

This appreciation of the functions of museums is a healthy sign, and might well be emulated in this country, where the museum is still commonly looked upon as a kind of "curiosity shop." Isolated attempts have been made on the part of many of our local museums to induce the public to make greater use of the collections exhibited for their benefit, but the Board of Education has yet to be educated in regard to the possibilities of museums. At the British Museum much valuable work is being done in the direction of economic zoology, but the scope of this work is hampered by lack of adequate financial support.

This very suggestive essay should be widely read in this country, for there can be no doubt that the educational advantages offered by our museums are little known or utilised by educational authorities.

MEASUREMENT OF THE DISTANCES OF THE STARS.[1]

FOR the lecture in honour and memory of Edward Halley, which it is my privilege to deliver this year, I have chosen an account of the persistent efforts made by astronomers to measure the distances of the fixed stars. For many generations their attempts were unsuccessful, though some of them led to great and unexpected discoveries. It is less than eighty years ago that the distances of two or three of the nearest stars were determined with any certainty. The number was added to, slowly at first, but afterwards at a greater rate, and now that large telescopes are available and photographic methods have been developed, we may expect that in the next few years very rapid progress will be made.

For many centuries astronomers had speculated on the distances of the stars. The Greeks measured the distance of the moon; they knew that the sun and planets were much further away, and placed them correctly in order of distance, guessing that the sun was nearer than Jupiter because it went round the sky in one year while Jupiter took twelve. The stars, from their absolute constancy of relative position, were rightly judged to be still more distant—but how much more they had no means of telling.

In 1543 Copernicus published "De Revolutionibus Orbium Cœlestium," and showed that the remarkable movements of the planets among the stars were much easier to understand on the hypothesis that the earth moved annually round the sun. Galileo's telescope added such cogent arguments that the Copernican system was firmly established. Among other difficulties which were not cleared up at the time one of the most important was this: If the earth describes a great orbit round the sun, its position changes very greatly. The question was rightly asked: Why do not the nearer stars change their positions relatively to the more distant ones? There was only one answer. Because they are so extremely distant. This was a hard saying, and the only reply which Kepler, who was a convinced believer in the earth's movement round the sun, could make to critics was "Bolus erat devorandus."

Although no differences in the positions of the stars were discernible to the naked eye, it might be that smaller differences existed which could be detected by refined astronomical measurements. To the naked eye a change in the angle between neighbouring stars not more than the apparent diameter of the sun or moon should be observable. No such changes are perceived. The stars are—it may be concluded—at least two hundred times as distant as the sun. With the instruments in use in the seventeenth century—before the telescope was used for the accurate measurement of angles—angles one-twentieth as large were measurable, and the conclusion was reached that the stars were at least four thousand times as distant as the sun. But no positive results were obtained. Attempts followed with the telescope and were equally unsuccessful. Hooke tried to find changes in the position of the star γ Draconis and failed. Flamsteed, Picard, and Cassini made extensive observations to detect changes in the position of the pole star and failed. Horrebow thought he had detected slight changes in the position of Sirius due to its nearness in a series of observations made by Römer. He published a pamphlet, entitled "Copernicus triumphans," in 1727, but the changes in the position of Sirius were not verified by other observers, and were due to slight movements of Römer's instruments.

Thus in Halley's time it was fairly well established that the stars were at least 20,000 or 30,000 times as distant as the sun. Halley did not succeed in finding their range, but he made an important discovery which showed that three of the stars were at sensible distances. In 1718 he contributed to the Royal Society a paper entitled "Considerations on the Change of the Latitude of Some of the Principal Bright Stars." While pursuing researches on another subject, he found that the three bright stars—Aldebaran, Sirius, and Arcturus—occupied positions among the other stars differing considerably from those assigned to them in the Almagest of Ptolemy. He showed that the possibility of an error in the transcription of the manuscript could be safely excluded, and that the southward movement of these stars to the extent of 37′, 42′, and 33′—*i.e.* angles larger than the apparent diameter of the sun in the sky—were established. He remarks:—

"What shall we say then? It is scarce possible that the antients could be deceived in so plain a matter, three observers confirming each other. Again these stars being the most conspicuous in heaven are in all probability nearest to the earth, and if they have any particular motion of their own, it is most likely to be perceived in them, which in so long a time as 1800 years may show itself by an alteration of their places, though it be utterly imperceptible in a single century of years."

This is the first good evidence, *i.e.* evidence which

[1] The "Halley Lecture" (slightly abridged), delivered at Oxford on May 20, by Sir F. W. Dyson, F.R.S., Astronomer Royal.

we now know to be true, that the so-called fixed stars are not fixed relatively to one another. It is the first positive proof that the distances of the stars are sensibly less than infinite. This, then, is the stage at which astronomers had arrived less than two hundred years ago. The stars are at least 20,000 or 30,000 times as distant as the sun, but three of the brightest of them are perceived to be not infinitely distant.

The greatest step in the determination of stellar distances was made by another Oxford astronomer, James Bradley. His unparalleled skill as an astronomer was early recognised by Halley, who tells how "Dr. Pound and his nephew, Mr. Bradley, did, myself being present, in the last opposition of the sun and Mars this way demonstrate the extreme minuteness of the sun's parallax, and that it was not more than 12 seconds nor less than 9 seconds." Translated from astronomical language, the distance of the sun is between 95 and 125 millions of miles. Actually the distance is 93 million miles. The astronomer who so readily measured the distance of the sun entered on the great research which had baffled his predecessors—the distance of the stars.

The theory of the determination of stellar parallax is very simple: the whole difficulty lies in its execution, because the angles are so small that the slightest errors vitiate the results completely. Even at the present time with large telescopes, and mechanism which moves the telescope so that the diurnal movement of the stars is followed and they appear fixed to the observer in the field of the telescope, and with the additional help of photography, the determination of the parallax of a star requires a good deal of care, and is a matter of great delicacy. But in Bradley's time telescopes were imperfect, and the mechanism for moving them uniformly to follow the diurnal rotation of the stars had not been devised.

This was in some ways very fortunate, as the method Bradley was forced to adopt led to two most important and unexpected discoveries. Every day, owing to the earth's rotation, the stars appear to describe circles in the sky. They reach the highest point when they cross the meridian or vertical plane running north and south. If we leave out all disturbing causes and suppose the earth's axis is quite fixed in direction, a star S, if at a great distance from the earth, will always cross the meridian at the same point S; but, if it is very near, its movement in the small parallactic ellipse will at one period of the year bring it rather north of its mean position and at the opposite period an equal amount south.

Bradley, therefore, designed an instrument for measuring the angular distance from the zenith, at which a certain star, γ Draconis, crossed the meridian. This instrument is called a zenith sector, and is shown in the slide. The direction of the vertical is given by a plumb-line, and he measured from day to day the angular distance of the star from the direction of the vertical. From December, 1725, to March, 1726, the star gradually moved further south; then it remained stationary for a little time; then moved northwards until, by the middle of June, it was in the same position as in December. It continued to move northwards until the beginning of September, then turned again and reached its old position in December. The movement was very regular and evidently not due to any errors in Bradley's observations. But it was most unexpected. The effect of parallax—which Bradley was looking for—would have brought the star furthest south in December, not in March. The times were all three months wrong. Bradley examined other stars, thinking first that this might be due to a movement of the earth's pole. But this would not explain the phenomena. The true explanation, it is said, although I do not know how truly, occurred to Bradley when he was sailing on the Thames, and noticed that the direction of the wind, as indicated by a vane on the mast-head, varied slightly with the course on which the boat was sailing. An account of the observations in the form of a letter from Bradley to Halley is published in the *Philosophical Transactions* for December, 1728:—

"When the Year was compleated, I began to examine and compare my Observations, and having pretty well satisfied myself as to the general Laws of the *Phenomena*, I then endeavoured to find out the Cause of them. I was already convinced that the apparent Motion of the Stars was not owing to a Nutation of the Earth's Axis. The next thing that offered itself, was an Alteration in the Direction of the Plumb-line, with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what Refraction might do, but here also nothing satisfactory occurred. At last I conjectured that all the *Phenomena* hitherto mentioned, proceeded from the progressive Motion of Light and the Earth's Annual Motion in its Orbit. For I perceived that, if Light was propagated in Time, the apparent Place of a fixed Object would not be the same when the Eye is at Rest, as when it is moving in any other Direction, than that of the Line passing through the Eye and the Object; and that, when the Eye is moving in different Directions, the apparent Place of the Object would be different."

This wonderful discovery of the Aberration of Light is usually elucidated by the very homely illustration of how an umbrella is held in a shower of rain. Suppose the rain were falling straight down and a man walking round a circular track: he always holds the umbrella a little in front of him—because when he is walking northward the rain appears to come a little from the north, when he is going eastward it appears to come a little from the east, and so on.

Although the phenomena Bradley had observed were almost wholly explained in this way, there were still some residual changes, which took nineteen years to unravel; and he explained these by a nutation or small oscillation of the earth's axis, which took nineteen years to complete its period. I cannot dwell on these two great discoveries. For our present purpose, it should be said that aberration and nutation cause far greater changes in the apparent positions of the stars than, we now know, are caused by parallax. Until they were understood and allowed for or eliminated, all search for parallax must have been in vain. Further, Bradley's observations showed that in the case of γ Draconis, at any rate, parallax did not displace the star by so much as 1·0″ from its mean position, or that the star was 200,000 times as distant as the sun. We may say that Bradley reached to just about the inside limit of the distances of the nearer stars.

Let me now try to give some idea of what is meant by a parallax of 1″, which corresponds to a distance 200,000 times that of the sun. Probably many of you have looked at the second star in the tail of the Great Bear, Mizar, it is named, and have seen there is a fainter star near it, which you can see nicely on a fine night. These stars are 600″ apart; with a big telescope with a magnification of 600 times—and this is about as high a magnification as can be generally used in England—two stars 1″ apart are seen double just as clearly as Alcor and Mizar are seen with the naked eye. I think this is the most useful way to think of 1″—a very small angle, which one needs a magnification of 600 times to see easily and clearly. Bradley showed that γ Draconis did not wander by this amount from its mean position among the stars in consequence of our changing view-point.

The next attempt to which I wish to refer is the one made by Sir William Herschel. In a paper communicated by him to the Royal Society in December, 1781, he reviews the serious difficulties involved in determining the parallax of a star by comparing its zenith distance at different times of the year. Especially there is the uncertainty introduced by the refraction of light, and in addition as the angular distances of stars from the zenith are changed by precession, nutation, and aberration, any errors in the calculated amount of these changes will all affect the results. He proposed, therefore, to examine with his big telescope the bright stars and see which of them had faint stars near them. The bright stars, he said, are probably much nearer than the faint stars; and if the parallax does not even amount to 1″ the case is by no means desperate. With a large telescope of very great perfection it should be possible to detect changes in the angular distance of two neighbouring stars. By this differential method the difficulties inherent in the method of zenith distances will be eliminated. Herschel made a great survey to find suitable stars, and in this way was led to the discovery of double stars *i.e.* of pairs of stars which are physically connected and revolve around one another, just like sun and earth. This was a most important discovery, but as the two components of a double star are practically at the same distance from us they do not serve to determine parallax, for which we need one star to serve as a distant mark.

For another forty years persistent efforts were made without success. Piazzi, in Italy, thought he had detected parallax in Sirius and a number of other bright stars, but the changes he detected in the zenith distances were unquestionably due to errors introduced by uncertainty in refraction, or slight changes in the position of his instruments in the course of the year. Dr. Brinkley, in Dublin, made a gallant effort and took the greatest pains. He thought he had succeeded, and for many years there was a controversy between him and Pond as to whether his results were trustworthy. The state of knowledge of the distances of the fixed stars in 1823 is summed up accurately by Pond in the *Philosophical Transactions*:—

"The History of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the Continent; and accordingly it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all."

Besides these and other efforts to find parallax in the zenith distances of stars, attempts were also made to detect changes in the time at which the stars cross the meridian, to see if they are slightly before their time at one period of the year and slightly after it at another. But these, too, were unsuccessful, even in the hands of astronomers like Bessel and Struve. The best were some observations of circumpolar stars made by Struve in Dorpat between 1814 and 1821. The following table shows some of the results at which he arrived:—

Polaris and ε Urs. Maj. ...	$\pi + 0{\cdot}053\pi' = +0{\cdot}075'' \pm 0{\cdot}034''$
ε Urs. Maj. and α Cass. ...	$\pi + 0{\cdot}962\pi' = -0{\cdot}136 \pm 0{\cdot}110$
ζ Urs. Maj. and δ Cass. ...	$\pi + 1{\cdot}099\pi' = +0{\cdot}175 \pm 0{\cdot}127$
β Urs. Min. and α Persei	$\pi + 0{\cdot}402\pi' = +0{\cdot}305 \pm 0{\cdot}071$
Capella and β Drac. ...	$\pi + 1{\cdot}147\pi' = +0{\cdot}134 \pm 0{\cdot}139$
β Aurig. and γ Drac. ...	$\pi + 1{\cdot}138\pi' = +0{\cdot}020 \pm 0{\cdot}117$

This table has the merit of not looking wildly impossible in the present state of our knowledge. It has the disadvantage of not giving a definite parallax to each star. For example, it is impossible to say how much of the 0·134″ is to be given to Capella and how much to β Draconis. Further, the probable errors, though really small, are nearly as large as the quantities determined.

Struve and Bessel therefore attempted the problem by the differential method recommended by Herschel. By this time it had become easier to carry out. The method of mounting telescopes equatorially had been devised, so that the telescope was always kept pointing to the same part of the sky by clockwork-driven mechanism. Struve chose the bright star α Lyræ, and measured its distance from a faint star about 40″ away on ninety-six nights between November, 1835, and August, 1838. In the focal plane of his telescope he had what is called a position micrometer. The micrometer contains two parallel spider-threads stretched on frames, and the frames are movable by screws until the position shown in the diagram is reached: the distance apart of the threads is known by the readings of the screw-heads. He found that α Lyræ had a parallax 0·262″ with a probable error ±0·025″.

Bessel chose the star 61 Cygni as a likely star to be near the sun, and therefore to have appreciable parallax. 61 Cygni is not nearly so bright as α Lyræ, but has a very great angular movement or proper-motion among the stars. Bessel used an instrument called a heliometer. Like Struve's telescope, it was mounted so that it could be driven by clockwork to point always at the same star. The object-glass of Bessel's telescope was made by the great optician Fraunhofer, with the intention of cutting it in halves. Fraunhofer died before the time came to carry out this delicate operation, but it was successfully accomplished after his death.

Delicate mechanism was provided for turning the glass, and also for moving the two halves, the amount of movement being very accurately measured by screws. Each half gives a perfect image of any object which is examined, but the two images are shifted by an amount equal to the distance one-half of the lens is moved along the other. Thus when a bright star and faint star are looked at, one-half of the object-glass can be made to give images S and *s*, and the other half S′ and *s*′. By moving the screw exactly the right amount *s*′ can be made to coincide with S, and the reading of the screw gives a measure of the angular distance between the two stars. Bessel made observations on ninety-eight nights extending from August, 1837, to September, 1838. The table, taken from a report by Main (Mem. R.A.S., vol. xii., p. 29), shows how closely the mean of the observations for each month accords with the supposition that the star has the parallax 0·369″:—

Mean date	Observed displacement ″	Effect of parallax 0″·369 ″
1837.		
August 23 ...	+0·197 ...	+0·212
September 14 ...	+0·100 ...	+0·100
October 12 ...	+0·040 ...	−0·057
November 22 ...	−0·214 ...	−0·258
December 21 ...	−0·322 ...	−0·317
1838.		
January 14 ...	−0·376 ...	−0·318
February 5 ...	−0·223 ...	−0·266
May 14	+0·245 ...	+0·238
June 19 ...	+0·360 ...	+0·332
July 13	+0·216 ...	+0·332
August 19 ...	+0·151 ...	+0·227
September 19 ...	+0·040 ...	+0·073

Simultaneously with these determinations of the distance of α Lyræ and 61 Cygni, the distance of α Centauri, one of the brightest of the southern stars, was found by Henderson from observations of zenith distance made by him at the Cape between April, 1832, and May, 1833. He learnt just before the termination of his residence at the Cape that this star had a very large proper-motion. Suspecting a possible parallax, he examined the observations when he had taken up his new office of Astronomer Royal for Scotland, and found a parallax amounting to 0·92″. He did not, however, publish his results until he found that they were confirmed by the right ascensions. In a communication to the Royal Astronomical Society in December, 1838, he states that it is probable that the star has a parallax of 1·0″.

The great and difficult problem which had occupied astronomers for many generations was thus solved for three separate stars in 1838:—

	Parallax	Distance	Modern observations Parallax	Modern observations Distance
α Centauri (Henderson)	″ 1·0	200,000	″ 0·750	270,000
61 Cygni (Bessel)	0·314	640,000	0·285	700,000
α Lyræ (Struve)...	0·262	760,000	0·10	2,000,000

(The unit of distance is that from the earth to the sun.)

Henderson's observation is interesting because α Centauri is, as far as we yet know, the nearest of all the stars to us. But by far the most valuable of these observations is Bessel's. The heliometer, which he devised, proved itself to be by far the most serviceable instrument for determining stellar parallax until the application of photography for this purpose.

The somewhat dramatic manner in which the distances of three stars were determined in the same year, after several centuries of failures, may have led to the hope that the range of many more stars would soon be found. This was not the case, however. Each star had to be measured separately, and involved many nights of observations. The quantities to be measured were so small that they taxed the resources of the best instruments and best observers. In 1843 Peters published the parallaxes of half a dozen stars determined with the vertical circle at Pulkova, but the parallax of only one of these, Polaris, is obtained with much accuracy. With Bessel's heliometer, Schlüter and Wichmann measured the distance of Gr. 1830, the star which had the largest known proper-motion. In the 'sixties, Auwers with the same instrument determined the parallax of several quick-moving stars, and also of the bright start Procyon. With the Bonn heliometer, Krueger in the 'sixties measured the distance of three stars, and Winnecke two more. Other observations were made, amongst others, by Maclear, Otto Struve, Brünnow, and Ball; but as these observers had not such suitable instruments, their results were not of the same high standard of value. A generous estimate would place the number of stars the distances of which had been satisfactorily determined before 1880 at not more than twenty.

In the 'eighties, progress became more rapid. Gill, the Astronomer Royal for the Cape, in conjunction with a young American astronomer, Elkin, determined with great accuracy, though with only a small 4-in. heliometer, the distance of nine stars of the southern hemisphere. These stars included α Centauri, and the bright stars Sirius and Canopus. These results were communicated to the Royal Astronomical Society in 1884. The work of Gill and Elkin did not stop there. After some years, a very fine 7-in. heliometer was obtained at the Cape, and with it, between 1888 and 1898, the parallaxes of seventeen stars were determined by Gill and his assistants with very great accuracy. The stars observed at the Cape consisted of the brightest stars of the southern hemisphere, and of the stars with the greatest proper-motions. The results were remarkable. The stars with large proper-motions were nearly always comparatively near—say within one million times the sun's distance. On the other hand, some of the very brightest stars, particularly Canopus, the brightest star in the sky after Sirius, were at vastly greater distances.

Meanwhile, Elkin, who had been appointed director of the Yale Observatory in 1884, carried out with a 6-in. heliometer, between the years 1885 and 1892, a determination of the distances of the ten brightest stars of the northern hemisphere. After these were finished the Yale observers, Elkin, Chase, and Smith, embarked on the ambitious programme of the determination of the distances of 163 stars of the northern hemisphere which show large proper-motion. They have added forty-one southern stars to these, and thirty-five stars of special interest. The results of all these observations were published in 1912. They have not, in most cases, the high accuracy of the Cape observations, but, nevertheless, are of great accuracy, and appear to be free from any considerable systematic error. A third important series of observations was made by Peter with a 6-in. heliometer at Leipzig. These were commenced about 1890, and continued until the death of Prof. Peter in 1911. The parallaxes of twenty stars were determined with the same high accuracy as the Cape observations.

Observations with the heliometer require both skill and industry. To secure the needful accuracy measures must be made in four different positions of the instrument, so that possible small systematic errors may be eliminated by reversal. Great care is required in the adjustments of the instrument, particularly in the accurate determination of the scale-value at different temperatures. The possibility of obtaining satisfactory results with less labour was considered by Kapteyn, in view of the successful determination of the parallax of Gr. 34 by Auwers. From 1885 to 1887 he made observations with the transit-circle at Leyden of fifteen stars for the purposes of determining parallax. The observation consisted in observing the time when the star the parallax of which was sought and two or three neighbouring stars crossed the meridian. Observations are made at the two most favourable epochs—say every night in March, and every night in September—to determine whether the star has changed its position relatively to its neighbours in the interval. The difficulties are twofold. The purely accidental error of observations of transits is considerable as compared with the small quantity which is sought. Besides this, the star of which the parallax is required is probably brighter than the comparison stars, and special precautions are required to guard against personal errors of the observer.

In questions of this kind the only satisfactory way is to judge by the results. From observations made on fifty nights, values of the parallax are obtained not nearly so accurate as the best heliometer observations, but still of considerable accuracy. Finally, the parallaxes of four of the stars which had been previously determined by measures with a heliometer showed satisfactory agreement.

This method has been employed by Jöst at Heidelberg, very extensively by Flint at the Washburn Observatory of the University of Wisconsin, and is now being tried at the Cape by Vouté, a pupil of Kapteyn's. It appears to me that this method can never give results of the highest accuracy, but that it may be of use in a preliminary search for stars of large parallax. The argument of the facility of the method compared with the heliometer has, however, lost much of its force; for, as I hope to show next, the highest accuracy attainable with the heliometer can be secured much more easily with a photographic telescope.

The application of photography to the determination of stellar parallax was first made by Pritchard in Oxford between 1887 and 1889. He took a large number of photographs and measured on them the angular distance of the star which he was considering from four of its neighbours. In this way he determined the parallax of five stars. He began this work late in life, and it was left for others to develop the photographic method and find what accuracy could be attained with it. At first sight it seems very easy, but experience shows that there are a number of small errors which can creep in and vitiate the results, unless care is taken to avoid them.

It has gradually become clear that with a few simple precautions and contrivances, a greater accuracy can be reached in the determination of parallax by photography and with much less trouble than by any other method. Between 1895 and 1905, several astronomers succeeded in obtaining from a few plates results as accurate as could be obtained from many nights' observations with the heliometer by the most skilled observers. In the last five years a large number of determinations have been made. In 1910 Schlesinger published the parallaxes of twenty-five stars from photographs taken with the 40-in. refractor of the Yerkes Observatory, and in 1911 Russell published the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge. The opinion expressed by Gill on these observations (*M.N.*, vol. lxii., p. 325), was that but for the wonderful precision of the Yerkes observations, the Cambridge results would have been regarded as of the highest class. The facility with which the Yerkes results are obtainable is expressed very tersely by Schlesinger—"the number of stellar parallaxes that can be determined per annum, will in the long run be about equal to the number of clear nights available for the work." With the heliometer at least ten times as much time would have been required. During the last year two further instalments of the results of the Yerkes Observatory have been published by Slocum and Mitchell, giving the parallaxes of more than fifty stars. It might be thought that the high accuracy attained by them is largely attributable to the great length of the telescope. From experience at Greenwich, I do not think this is the case, and believe that similar results are obtainable with telescopes of shorter focal length. As several observatories are now occupied with this work, we may expect that the number of stars the distances of which are fairly well known will soon amount to thousands, as compared with three in 1838, about twenty in 1880, about sixty in 1900, and now perhaps two hundred.

The stars the distances of which have been measured have generally been specially selected on account of their brightness or large proper-motion. Each star has been examined individually. Kapteyn has suggested that instead of examining stars singly in this way, photography gives an opportunity of examining all the stars in a small area of the sky simultaneously, and picking out the near ones. The method has been tried by Kapteyn and others—among them Dr. Rambaut. The idea is very attractive, because it examines the average star and not the bright star or star of larger proper-motion. It is liable, however, to some errors of systematic character, especially as regards stars of different magnitudes. Comparison of the results so obtained with those found otherwise will demonstrate whether these errors can be kept sufficiently small by great care in taking the photographs. Until this is done no opinion can be expressed on the success of this experiment, which is worth careful trial.

The question may be asked, How near must a star be to us for its distance to be measurable? I think we may say ten million times the sun's distance. This corresponds to the small angle 0·02″ for the parallax. If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities, and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second: that it gives out forty-eight times as much light as the sun, but is only two and a half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results. But it is not my purpose to deal with this to-night. The task I set before myself in this lecture was to give an idea of the difficulties which astronomers have gradually surmounted, and the extent to which they have succeeded in measuring the distances of the stars.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rev. T. C. Fitzpatrick, president of Queens' College, has been elected Vice-Chancellor for the coming academic year.

The council of the Senate has announced that the Board of Education has agreed to make a grant in aid of the medical departments of the University, and that the amount to be received on account of the present year is 5873*l.*; it proposes that a new committee, to be called the Medical Grant Committee, should be appointed for the purpose of administering the annual grant.

Mr. H. Scott, of Trinity College, has been appointed curator in entomology for five years from March last.

A grant of 50*l.* has been made from the Balfour Fund to enable Mr. G. Matthai, of Emmanuel College, to visit America in furtherance of his researches on the comparative anatomy and classification of the Madreporaria.

GLASGOW.—By an Order in Council dated May 27, 1915, the King has reappointed Sir Donald MacAlister and Mr. Otto Beit, and has appointed Mr. R. E. Prothero, to be members of the governing body of the Imperial College of Science and Technology for a term of four years from June 1, 1915.

LONDON.—Owing to Prof. Brodie's services being required for military purposes, the course of advanced lectures in physiology arranged to be given by him at King's College (as announced last week) will not be delivered.

OXFORD.—The report of the delegates of the University Museum for 1914, together with the departmental reports of the professors and readers teaching within the Museum, has just been published. In the general report attention is directed to the departure of large numbers of the teaching and service staff, and also of research workers, for military duties. This has affected both the Museum itself and also the several departments. Mention is made of the billeting of the 9th Battalion of the Hampshire Regiment for a night in some of the laboratories; of the presentation to the University of Mr. Hope Pinker's statue of Roger Bacon; and of the completion of the carving in the upper corridor, under the bequest of the late Rev. H. T. Morgan.

The report of the Professor of Pathology records the fact that from an early date in August the department and the whole of its staff were engaged in services connected with the war. About 6000 inoculations were performed, and a quantity of vaccine was sent to Belgium. The Professor of Physiology includes in his report a tribute to the services rendered by the late Dr. G. J. Burch, F.R.S., and an account of the arrangements for the memorial to the late Prof. Francis Gotch, F.R.S. Most of the departmental reports, including that of the Curator of the Pitt-Rivers Museum, contain long lists of donations to the respective collections, and full records of the research work which, in spite of all obstacles, has been carried on in the various laboratories and workrooms of the Museum.

The new building for engineering science was finished at Christmas. The new chemical laboratory is still in course of erection, but the professor hopes that it will be ready for occupation by next October.

Science announces that the Michigan Legislature has granted 70,000*l.* for the erection of a new university library building for the University of Michigan.

The fiftieth anniversary celebration of the Worcester Polytechnic Institute, Worcester, Massachusetts, is to be held on June 6–10. President Wilson, who gave the opening address on a similar occasion twenty-five years ago, hopes, if the pressure of public business makes it possible, to attend the meetings on June 9. General G. W. Goethals has also accepted an invitation to be present. On June 10, honours are to be conferred and various bronze tablets unveiled.

A free scholarship of the value of 30*l.*, open to all-comers, and tenable at the Northampton Polytechnic Institute (London), is being offered to students. In view of the opportunities for advancement which the calling and craft of optics now offer on account of the shutting off of alien supplies due to the war, the "Aitchison Memorial Scholarship," which has for its special object the encouragement of recruits for the optical industry, should prove very attractive to intelligent youths. The subjects of examination include English, mathematics, and elementary physics. The conditions of the scholarship have been laid down by a committee which includes Dr. R. Mullineux Walmsley, Prof. Silvanus P. Thompson, and Dr. J. W. Ettles. Full particulars can be had of the hon. secretary and treasurer, Mr. Henry F. Purser, 35 Charles Street, Hatton Garden, London, E.C.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 20.—Sir William Crookes, president, in the chair.—H. **Moore**: The corpuscular radiation liberated in vapours by homogeneous X-radiation.—H. **Richardson**: The absorption in lead of γ rays emitted by radium B and radium C. (1) The absorption curves in lead of the radiations emitted by radium B and radium C have been determined and analysed. (2) In addition to the penetrating type of radiation for which $\mu=0{\cdot}5$ (cm.$^{-1}$) in lead, radium C has been found to emit soft types for which $\mu=46$, $\mu=6{\cdot}0$, and $\mu=1{\cdot}5$, and which are practically absorbed by 1·5 cm. of lead. (3) The analysis of the radium B absorption curve shows that in addition to the radiation $\mu=40$ in aluminium, the rays emitted consist of three types for which $\mu=46$, $\mu=6{\cdot}0$, and $\mu=1{\cdot}5$ for lead. The close similarity of this latter radiation with that of the soft portion emitted by radium C, already observed by Rutherford and Andrade, has been established. (4) The absorption of the radiations in different elements has been examined and the bearing of the results discussed. No evidence of anomalous absorption has been found in the case of the penetrating radiations.—T. R. **Merton**: The application of interference methods to the study of the origin of certain spectrum lines. By measuring the limiting orders at which interference can be detected for different radiations, certain deductions may be made as to the mass of the luminous particles and the temperature of the source. If the only circumstance which could possibly influence the width of spectrum lines at low pressures were the Doppler effect due to the motion of the luminous particles in the line of sight, the relative masses of particles emitting radiations from the same source of light might be calculated. As, however, there is reason to doubt the validity of this assumption under certain conditions, the conclusions which may be drawn with certainty from measurements of this kind are an inferior limit for the mass of the luminous particles if the temperature of the source is known, or a superior limit to the temperature if the mass of the luminous particles is assumed. It is shown in the paper that the flame lines of calcium, strontium, and barium are probably due to molecules, whilst the H and K lines of calcium are to be attributed to calcium atoms. As the flame lines are members of series, it must be recognised that radiations from molecules may give rise to line series as well as band spectra. Lines of the two spectra of argon have been investigated. The width of the lines of the red spectrum would appear to be accounted for by the Doppler effect. The lines of the blue spectrum are very broad in comparison with those of the red spectrum, and a satisfactory explanation of this has not been found. Spectrum lines of the "arc" type are broadened when condensed discharges are used as the method of excitation, but the difference in width of the lines in the blue and red spectra of argon is of another order of magnitude. The band spectrum associated with helium has been found to be enhanced when the gas is cooled to the temperature of liquid air, which might justify the suspicion that more than one atom was concerned in its production, but a comparison of the widths of the lines in the band spectrum with the ordinary helium lines makes it extremely probable that the band spectrum is due to atomic helium.

Physical Society, May 14.—Dr. A. Russell, vice-president, in the chair.—E. H. **Rayner**: Precision resistance measurements with simple apparatus. The paper describes methods by which the comparison of resistances can be made to an accuracy of 1 in 10,000 or higher by using simple apparatus usually available in electrical laboratories, or which can be easily constructed with little skilled assistance. The comparison of nominally equal resistances of 1 ohm and upwards by the usual method of shunting one side of a nearly balanced quadrilateral by a high resistance is mentioned, and variations on this when only part of one resistance is shunted are often useful. The great advantages of having resistances capable of carrying comparatively large currents are illustrated, especially for measuring changes of resistance of commercial apparatus under working conditions. The determination of errors in a volt box for use with a potentiometer is described at some length. This is of especial importance in precision photometry. If a sufficient continuous-current voltage is not available for testing such apparatus as high-potential dividers, it is shown that using sufficient continuous current to secure sensitivity the heating may be supplied by superposed alternating current. Resistances in common use are very generally of simple numerical value, and a Kelvin bridge specially designed for the comparison of such resistances is described. It consists essentially of two rows of 25 resistances of 20 ohms each.—G. F. W. **Jordan**: Some novel laboratory experiments. (1) Condensation calorimeters for the measurement of latent and specific heats. (*a*) It is shown how an ordinary vacuum jacket flask can be converted into a suitable condensation calorimeter. Errors arising from loss of heat and wetness of the vapour are almost eliminated by making two experiments. (*b*) Another condensation calorimeter is constructed on a different plan with a view to the elimination of the same errors. (2) The thermal conductivity of a narrow metal bar. Gray's apparatus for the measurement of the conductivity of a narrow bar has been modified for the purpose of rendering the loss of heat relatively small and reducing the time taken in the measurement, thus introducing the experiment to the elementary student. (3) The measurement of Poisson's ratio for a rectangular lath. Two mirrors are attached to opposite sides of the bent lath for the measurement of the anti-elastic radius of curvature, and Poisson's ratio is then deduced from the observations in the usual manner. (4) A method of measuring the coincidence period of a kater and a clock pendulum. The kater and the clock pendulums are electrically connected so that when at the centres of their swings a momentary current passes through a telephone receiver. (5) A differential telephone receiver. An ordinary receiver is connected to the secondary of a simple differentially wound transformer, and it is thus converted into a differential receiver for the purpose of electrical measurement. (6) Experiment on interference fringes. The fringes produced by a Lloyd's mirror in white light are nearly achromatised by a simple grating on smoked glass. Other suggestive interference effects with the grating are also described. —S. **Butterworth**: Electrically maintained vibrations.

Royal Meteorological Society, May 19.—Major H. G. Lyons, president, in the chair.—Dr. H. R. **Mill** and H. E. **Carter**: The wet winter of 1914–15. The authors dealt fully with the abnormal rainfall of the four months, November, 1914, to February, 1915, and showed that the general rainfall for England and Wales for this period was 20·21 in. A striking feature of the comparison with the average is that the area with less than 12 in. of rain was barely one-tenth part of the area on the average map, while the area with more than 30 in. was nearly seven times as great as on the average map. December was by far the wettest month, the general rainfall being 211 per cent. of the average; in November it was 134 per cent.; in January 143 per cent.; and in February 198 per cent. of the average. The persistent nature of the rainfall caused extensive floods over practically all the low-lying parts of the country. The wettest previous winters were those of 1876–77 and 1911–12, that of 1914–15 was shown to be wetter than either of them. —J. E. **Clark**: Report on the phenological observations from December, 1913, to November, 1914. The report was based on the returns from 133 stations in various parts of the British Isles. This was the fourth successive mild year, the mean date for the plant records being a week earlier than the average. The dominating factors were the abnormally mild autumn of 1913, the mild winter, and remarkably genial April weather. Fruits and crops were prejudiced by the serious May frosts and droughty conditions from mid-April to October; on the other hand, the sunny warmth of the autumn largely contributed to make the year successful for the farmer and partially so to fruit-growers.

PARIS.

Academy of Sciences, May 25.—M. Ed. Perrier in the chair.—S. **Lattès**: Linear multiplicities invariant by a given linear substitution.—Ed. **Bourquelot**, M. **Bridel**, and A. **Aubry**: The biochemical synthesis of the α-mono-d-galactoside of ethylene glycol. The galactoside was obtained by the action of an extract of low yeast upon an aqueous solution of ethylene glycol and galactose during a period of nine months. A description is given of the process of purification, which offered some difficulties, and of the physical properties and hydrolysis of the α-galactoside.—Alphonse **Berget**: The capillary constant of sea water. From measurements of the surface tension of sea water and of distilled water it is shown that the difference is sufficiently great to cause an error in density measurements made with a hydrometer of rather more than one part in a thousand.—Pierre **Lesage**: The pedicels of *Lunularia vulgaris*.—Eugène **Pittard**: Comparative anthropometry of the Balkan peoples. Supplementing an earlier paper with statistics of the cephalic index and anthropometric characters of the face.—Jules **Glover**: Telephony without transmission of the sound waves through air.—Jean **Villey**: A method for the radioscopic localisation of projectiles in the human body. The series of operations required by the one method are purely mechanical and dispense with calculations or photographic plates. Full details of the technique are given.—J. P. **Dubarry**: Anti-typhoid vaccination by the gastro-intestinal method. A comparison of the results obtained by the hypodermic and gastro-intestinal methods of inoculation.—E. **Roubaud**: The destruction of flies and the disinfection of bodies in the war zone. The use of cresylic acid, heavy tar oil, and ferric sulphate are recommended, and the specific action of each of these described.

CAPE TOWN.

Royal Society of South Africa, April 21.—Dr. L. Péringuey, president, in the chair.—Dr. L. **Péringuey**: *Presidential Address*:—"The Bushman as a Palæolithic Man."—Ethel M. **Doidge**: Some notes on the South African Erysiphaceæ. The paper consists of notes on the South African representatives of the "powdery mildews." These cause a number of widely distributed and more or less destructive diseases of plants in this country; but they are not easily identified owing to the almost invariable absence of perithecia. The species occurring in South Africa are enumerated, and a list given of the specimens contained in the Union Mycological Herbarium, Pretoria. Two new specimens of the genus Uncinula are described.—A. W. **Rogers**: Geitsi Gubib, an old volcano: A geological description is given of Geitsi Gubib, a ring-shaped mountain in German South-West Africa, rising about 5200 ft. above sea-level, and a conspicuous object from the railway north of Keetmanshoop. The description is based on notes taken during a stay by the author of two days on the mountain, and on the examination of the rocks brought away.

BOOKS RECEIVED.

Pendlebury's New Concrete Arithmetic. By C. Pendlebury and H. Leather. Sixth Year. Pp. 80. (London: G. Bell and Sons, Ltd.) 6*d*.

Experimental Electricity and Magnetism. By M. Finn. Pp. x+436. (London: G. Bell and Sons, Ltd.) 4*s*. 6*d*.

Plants and their Ways in South Africa. By Dr. B. Stoneman. New edition. Pp. xii+387. (London: Longmans and Co.) 5*s*.

Experimental Plant Physiology for Beginners. By

L. E. Cox. Pp. vii+111. (London: Longmans and Co.) 2s. net.

Union of South Africa. Department of Agriculture. Report with Appendices for the Year, April 1, 1913, to March 31, 1914. Pp. 299. (Cape Town: Cape Times, Ltd.) 7s. 6d.

Zròdla Podświadomości i jej Przejawy. By E. Abramowski. Pp. 207 (Warszawa: Drukarnia Polska.) 1.50 kop.

Podstawy Naukowe Elektrotechniki Lacznie Z Zasadami Pomiarów, M. Pozaryski. Pp. x+415. (Warszawa: Gebethnera i. Wolffa.) 2.40 kop.

Institut Psychologiezny W Warszawie. Prace z Psychologii Dòswiadczalnej. Edited by E. Abramowskiego. Tom. ii. Pp. xii+362. (Warszawa: Gebethnera i. Wolffa.) 1.80 kop.

Zagadnienia dotyczace gieometrji Elementarnej zebral i Ulozyl F. Enriques. Tom. i. Pp. iv+331. (Warszawa: Gebethnera i. Wolffa.) 1.50 kop.

Towarzystwo Naukowe Warszawskie. By E. Loth. Pp. v+71. (Warszawa: Gebethnera i. Wolffa.) 75 kop.

M. Faraday Dzieje Swiecy sześć wykladów popularnych W. Przekladzie Marji i. Stanislawa Kalinowskich. (Warszawa: Gebethnera i. Wolffa.) 50 kop.

Biblioteka Matematyczno-Fizyczna. Serya iii. x. Teorya Liczb (Kurs Uniwersytecki). Dr. W. Sierpiński. Pp. xiv+412. (Warszawa: Gebethnera i. Wolffa.) 1.80 kop.

The Limitations of Science. By Prof. L. T. More. Pp. 268. (New York: H. Holt and Co.) 1.50 dollars net.

Wisconsin Geological and Natural History Survey. Bulletin No. xxxiii. Scientific Series. No. 10. The Polyporaceæ of Wisconsin By J. J. Neuman. Pp. 206+xxv plates. Bulletin No. xli. Economic Series. No. 18. A Study of Methods of Mine Valuation and Assessment, with Special Reference to the Zinc Mines of South-western Wisconsin. By W. J. Uglow. Pp. 73. (Madison, Wis.)

Surface Tension and Surface Energy and their Influence on Chemical Phenomena. By Dr. R. S. Willows and E. Hatschek. Pp. viii+80. (London: J. and A. Churchill.) 2s. 6d. net.

Plant Breeding. By L. H. Bailey. New edition. Revised by Dr. A. W. Gilbert. Pp. xviii+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8s. 6d. net.

Royal Botanic Gardens, Kew. Hand-list of Tender Monocotyledons. excluding Orchidaceæ, cultivated in the Royal Botanic Gardens. Second edition. Pp. 241. (London: H.M.S.O.: Royal Gardens, Kew.) 1s. 6d.

The Book of the Fly. By G. H. Hardy. Pp. 124. (London: W. Heinemann.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, June 3.

Royal Society, at 4.30.—The Shapes of the Equipotential Surfaces in the Air near Long Buildings or Walls, and their Effect on the Measurement of Atmospheric Potential Gradients: Prof. C. H. Lees.—The Influence of Gases on the Emission of Electrons and Ions from Hot Metals: Prof. O. W. Richardson.—The Band Spectrum associated with Helium: J. W. Nicholson.—Soil Protozoa and Soil Bacteria: E. J. Russell.—The Chromosome Cycle in Coccidia and Gregarines: C. Dobell and A. P. Jameson.

Royal Institution, at 3.—Methods of presenting Character in Biography and Fiction: Wilfrid Ward.

FRIDAY, June 4.

Royal Institution, at 9.—Radiations from Exploding Atoms: Sir E. Rutherford.

Geologists' Association (at University College), at 8.—Lakes and their Origin, with Special Reference to Rock-basins: Prof. E. J. Garwood.

MONDAY, June 7.

Royal Institution, at 3.—Method of Presenting Character in Biography and Fiction: Wilfrid Ward.

Society of Chemical Industry, at 8.—A New Process for the Refining of Chile Saltpetre: J. B. Hobsbaum.—A Method of Testing Mineral Lubricating Oils for use in Forced Lubricating Systems for Steam Turbines: Arnold Philip.—The Application of Adobe as a Material for the Construction of Buildings for the Manufacturing and Storing of Explosives: Major Ferriz.

Victoria Institute, at 4.30.—The Old and New Versions of the Babylonian Creation and Flood Stories: Dr. T. G. Pinches.

Aristotelian Society, at 8.—Some Theories of Knowledge: Dr. F. Aveling.

TUESDAY, June 8.

Royal Institution, at 3.—The Evolution of Steel—Influence on Civilisation: Prof. J. O. Arnold.

Zoological Society, at 5.30.—The Feet and Glands and other External Characters of the Paradoxurine Genera Paradoxurus, Arctictis, Arctogalidia, and Nandinia: R. I. Pocock.—The Skull of an Extinct Carnivore related to Aeluropus, from a Cavern in the Ruby Mines, Mogok, Burma: Dr. A. Smith Woodward.—The Early Development of the Heart and Anterior Vessels in Marsupials, with Special Reference to Perameles: Miss K. M. Parker.—The Triassic Stegocephalians, Brachyops, Buthriceps, and Lydekkerina, gen nov.: Dr. R. Broom.

WEDNESDAY, June 9.

Geological Society, at 8.—The Accessory Minerals of the Granitic Rocks of the English Lake District: R. H. Rastall and W. H. Wilcockson.

THURSDAY, June 10.

Royal Institution, at 3.—Method of Presenting Character in Biography and Fiction: Wilfrid Ward.

Royal Geographical Society, at 5.—The History of the Gradual Development of the Groundwork of Geographical Science: Sir Clements Markham.

Institute of Actuaries, at 5.—Annual General Meeting.

FRIDAY, June 11.

Royal Institution, at 9.—Music and Poetry: Dr. H. W. Davies.

Royal Astronomical Society, at 5.

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THURSDAY, JUNE 10, 1915.

SCHOOL SCIENCE.

Elements of General Science. By Dr. O. W. Caldwell and W. L. Eikenberry. Pp. xiv+308. (London: Ginn and Co., n.d.) Price 4*s.* 6*d.*

In every school in this country there is found a small percentage of boys or girls who have a decided bent towards experiment of a thoughtful character coupled with a thirst for knowledge of natural phenomena. The science master who knows his business will speedily recognise such a boy and apply the appropriate treatment, which usually consists in the suggestion of extra problems to be worked out in the laboratory, and of extra reading, selected to fit the need of the moment and create further needs for future satisfaction. Guided, but not overhelped, these boys will soon be fit for enlistment as recruits to the army of scientific investigators. When framing the syllabus of the general science course of the school, there is no need to provide for the training of specialists. There is need, and very great need, to provide a course of science work for the average boy and girl which will (1) be in touch with everyday experience, (2) deal with matters of wide interest and importance, (3) give some appreciation of what scientific experiment means and of what scientific synthesis is capable. At the end of the course, if the pupil wishes to know more and has acquired some power of satisfying that wish by his own efforts, if his attitude towards the opinions and labours of specialists is one of rational respect, the work may be pronounced a success.

The authors of the school-book under review have clearly had in mind the needs (1) and (2) stated above, as they have throughout dealt with live topics of major importance. The contents table of the book shows a richness in the quantity and quality of the topics—beginning with air and the barometer, and concluding with heredity and environment—which makes the ordinary syllabus of an English school appear poverty-stricken by comparison. Unfortunately, the third requisite for a satisfactory school course is not fulfilled—there is nothing in this book which teaches the meaning of experiment, and consequently little hope that it will educe an appreciation of scientific method. The material accomplishments of applied science will not fail to be acknowledged; but of the human interest of investigation (apart from its results) and of the beauty of a universe lawful to its core, there is no revelation in these pages.

Prof. C. H. Judd, of the University of Chicago, in an "Introduction" to the book, speaks of the "inhibition of science" in school organisation. Have we not in England also experienced some disappointment with the results of school science? A comparison of American and English methods suggests that their merits and defects are complementary, that while America still hustles her pupils through a pemmican meal of dogmatic information, England keeps hers practising the goose-step of "determining the density of the given solid." In neither country is there sufficient *real* experimenting, and proper correlation with mathematics, geography, workshop practice, and art is too often to seek English teachers might gain by pondering the valuable content of the lessons in this book; while we venture to hope that more regard for heuristic principles, even at some sacrifice of information-getting, may help to remove "the inhibition of science" of which Prof. Judd complains.

G. F. D.

PRACTICAL PLANT PHYSIOLOGY.

Ernährungsphysiologisches Praktikum der höheren Pflanzen. By Prof. V. Grafe. Pp. x+494. (Berlin: P. Parey, 1914.) Price 17 marks.

The books dealing with the practical side of advanced plant physiology are so few in number that any addition to them is very welcome. As the title indicates, Prof. Grafe's work deals only with the metabolic side of plant physiology, the phenomena included under the term irritability being excluded from the scope of the work. The book differs from all previous works on practical plant physiology in its size—it is a quarto volume of nearly five hundred pages—and also in its purpose, since it is designed mainly as a help in research work, rather than for teaching purposes as are the well-known works of Darwin and Acton, Detmer, and Ganong.

The author is well known for his chemical work in plant physiology, so, as we should expect, the biochemical aspect of the subject is the one that is most elaborated. He states in his preface that the book has arisen in response to the need for a guide in his own chemico-physiological practical work, and that it is meant to stand midway between such practical books as those already mentioned and Abderhalden's "Handbuch der Biochemischen Arbeitsmethoden." The work, however, is more than a mere practical book, for under many of the sections we find, besides a description of the methods to be used, also a statement of the results obtained by such methods.

The book deals first with the swelling of the seed and the effect of external conditions on germination and on the growth of seedlings, including the methods of water culture. Then we have a section on ash-analysis and on carbon dioxide assimilation, which includes the qualitative and quantitative determination of the products of photosynthesis; a section on fats, oils, and waxes, on nitrogen-assimilation, on enzymes, tannins, glucosides, caoutchouc, etc. There are also sections on a "complete" analysis of a plant, and on respiration. Finally, we have a number of sections of a miscellaneous nature, such as the sterile culture of the higher plants, the determination of the surface tension, permeability, and osmotic pressure of plant cells, the use of ether, hot water, and other means for producing precocious sprouting, the measurement of growth, "bleeding," and transpiration. Finally, tables are given showing the colour changes of various indicators for the determination of the hydrogen-ion concentration of cell-saps by means of Friedenthal's method.

In a work of this size there are, of course, many points at which one might cavil, and in particular English and American work should have received fuller recognition. There is, however, no doubt that Prof. Grafe has laid all plant physiologists under a heavy debt of gratitude by the production of so useful a book of reference.

V. H. B.

MATHEMATICAL PRINCIPLES AND PRACTICE.

(1) *Longman's Modern Mathematical Series. Exercises in Algebra (including Trigonometry).* By Dr. T. P. Nunn. Part i. Pp. x+421. Price 4*s.* Part ii. Pp. xi+551. Price 6*s.* 6*d.* *The Teaching of Algebra (including Trigonometry).* By Dr. T. P. Nunn. Pp. xiv+616. Price 7*s.* 6*d.* (London: Longmans, Green and Co., 1914.)

(2) *Workshop Arithmetic.* By F. Castle. Pp. viii+173. (London: Macmillan and Co., Ltd., 1915.) Price 1*s.* 6*d.*

(3) *Plane Trigonometry.* By Prof. H. S. Carslaw. Pp. xviii+293. Price 4*s.* 6*d.* *Solutions of the Questions in Plane Trigonometry.* By Prof. H. S. Carslaw. Pp. 179. Price 6*s.* 6*d.* net. (London: Macmillan and Co., Ltd., 1915.)

(4) *Numerical Trigonometry.* By N. J. Chignell. Pp. xii+126. (Oxford: Clarendon Press, 1914.) Price 2*s.* 6*d.*

(5) *Longman's Modern Mathematical Series. Exercises in Arithmetic and Mensuration.* By P. Abbott. Pp. ix+524. With Answers. (London: Longmans, Green and Co., 1913.) Price 4*s.* 6*d.*

(1) PROF. NUNN'S three volumes form a unique treatise on the study of algebra. Beginning from the first notions in the subject he separates the educational grain from the educational chaff, and gives us the grain. So much is found fit for discarding as chaff that the author finds space for treating trigonometry, Cartesian geometry, and the calculus, in addition to a discussion of such recent work as that on the complete number-scale.

Throughout the book Prof. Nunn's knowledge of psychology is brought to bear to improve the order of treatment. In the customary treatment negative quantities are introduced early, and form a serious stumbling block. Prof. Nunn restricts the subject to "non-directed quantities" for a considerable time. In consequence the pupil first meets negative quantities at a more mature age and with a mind more developed algebraically, and is better fitted to grasp the new idea.

The complete number-scale is introduced with the view of clearing up the doctrine of limits. The treatment is lucid and simple, and the student of this book will gain clear views on a matter on which even the best writers of books on the calculus have hitherto gone wrong. The book is one in a thousand, and all students who go beyond the non-specialist school course will gain enormously by its study.

(2) Castle's "Workshop Arithmetic" is a book on which a boy would be glad to be brought up even if he is not destined to be an engineer or builder (for whom the book is specially designed). The questions come straight from the workshop and other everyday sources, and the human interest never fails. While the author's language sometimes jars upon us, as when he says, "Compute the following operation, $471{\cdot}99 \div 2{\cdot}363$" (p. 7), or "The objects are not the same dimension at different places" (p. 30), we yet fear that present-day usage justifies this use of *operation,* and the omission of a preposition before *the same dimension.* The largeness of the square ruling of some diagrams deserves a special word of praise for its clearness.

(3) Prof. Carslaw's "Trigonometry" passes over the early portions of the subject rapidly. It is suited to the strong digestion of the specialist schoolboy and to university students. It holds a midway position between the older style of book which includes all the attractive backwaters and exercises in manipulation, and the modern book which aims at putting a useful tool in the student's hands and restricting proofs and explanations to bare necessities. The book includes all that has been customary, and improves on the older books by introducing numerical work at an early stage. It is well suited to the many teachers who desire the new but hesitate to break with the old. The solutions in the key show careful work,

and the type is excellent in both books—the text and the key.

(4) Mr. Chignell's book is planned on the wise modern method of beginning trigonometry with a numerical treatment of the ratios, and postponing the addition theorem and other formulas until the student has thoroughly grasped the meaning of the ratios. The solution of the oblique triangle is effected by dividing it into two right-angled triangles, a simple method which is in every way sufficient for non-specialists; the half-angle formulas were invented for astronomical use, and may very well be left to astronomers and other specialists. The quantity of exercises is ample for all purposes, and the wise schoolmaster will use only a minimum number of the introductory tests and pass rapidly on to the "problems" of human interest.

(5) For the students who use Mr. Abbott's book the bad old rule-of-thumb days are over. Vulgar fractions are introduced in most practical fashion, fractions of lengths and areas being shown in diagrams. Then follow decimals in equally practical fashion by means of the paper abacus which served merchants up to the time of the invention of the zero; and so on in corresponding treatment throughout the range of mensuration.

The relation $(a+b)^2=a^2+b^2+2ab$ we are pleased to see treated as the algebraic expression of a property which is fundamentally geometrical; too often the relation is taken to be fundamentally algebraic, and the geometrical property reduced to the status of an illustration. The square-ruled diagrams are sometimes in tenths of an inch and sometimes in millimetres. The former are better, the latter being trying to the eye; and for many purposes quarter-inch or half-centimetre ruling would be better than either. The bulk of the exercises have the great merit of being drawn from human life. D. B. M.

OUR BOOKSHELF.

Practical Irrigation and Pumping. By B. E. Fleming. Pp. xvi+226. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8*s*. 6*d*. net.

It is somewhat difficult for the inhabitants of a country intersected by numerous streams and characterised by an ample and fairly uniform rainfall, to realise the disabilities under which agriculturists labour in other lands less favoured with automatic supplies of natural moisture. The great plains of India, the immense tract of Egypt and the Sudan, and the vast expanse of North America lying west of the 100th meridian, comprising some dozen States and forming about one-third of the total area of the United States, are instances of those arid regions in which it is impossible, without artificial aid, to render the soil productive in any effective degree. What this means may be gauged from a statement in the prefatory note of the volume before us, that up to July, 1910, it is estimated that a sum of more than 60,000,000*l*. had been sunk in the reclamation, by irrigation, of 14,000,000 acres in the Western States of America.

The purview of Mr. Fleming's book is limited to a consideration of irrigation by means of pumping underground water, as practised in the United States, and in so far as this aspect of the subject is concerned, it is treated fairly comprehensively. The author enters succinctly, and at the same time with some degree of detail, into the various problems connected with the sinking of wells and the installation of a pumping plant. Considerable space is devoted to a discussion of the merits and capabilities of the centrifugal pump, and a noticeable feature is the number of performance diagrams of various-sized pumps of this type. Reciprocating pumps are only lightly touched upon. Prime movers and windmills are described. There is a chapter on the cost of pumping operations which contains some useful information; the governing conditions, as already stated, are those prevailing in the Western States, and, consequently, the facts are not generally intended for wider application. Within the limits set down by the author, this little volume is an interesting and practical handbook, based on his personal experience, some of which, he remarks, has been "rather bitter." B. C.

Brazil (1913). By J. C. Oakenfull. Fifth Edition. Pp. viii+604. (Frome: Butler and Tanner 1914.) Price 7*s*. 6*d*. net.

This account of Brazil is the fifth revised edition of a handbook originally published in 1909, and distributed at the cost of the National Government. It discusses in detail the geography, history, natural productions, and economic resources of a country including an area of 8½ million kilometres and an estimated population of 24 millions. The book is well arranged, the information is based on the most recent official reports, and it is provided with good maps and illustrations. Brazil in its geographical features presents the most varied characteristics—the great river basins of the Amazon-Tocantins and La Plata, a shapeless mass of highlands, and a narrow coastal region. In its highland region suited for an agricultural and pastoral life, its vast forests providing unlimited supplies of valuable timber, its coffee, sugar, tobacco, and other useful products, it remains one of the few areas suitable for extensive development by settlers from Europe, a fact which has been fully grasped by the German Government, ever in search of new colonies and desirous of securing a footing on the continent of America.

The book is admittedly intended to press the claims of Brazil on the colonist. Since 1820 3¼ millions of emigrants, of whom the majority are Italians, have reached its shores, and progress has recently been made in attracting Japanese emigrants. But Mr. Oakenfull goes beyond his brief when he dwells on the superiority of Brazil to the British Colonies, particularly in relation to the price of land. It must be remembered that Brazil is as yet only partially developed, and the present economic situation may be gauged by the value of the national securities. While Canada 3 per cents. are now quoted at 83, Brazil 4 per cents. of 1910 stand at 49. No doubt this is owing to temporary causes, but for the intending emigrant the contrast is significant.

Improved Four-Figure Logarithm Table, Multiplication and Division Made Easy. By G. C. McLaren. Pp. 27. (Cambridge: At the University Press, 1915.) Price 1s. 6d. net.

THESE tables aim at popularising logarithms. Like other four-figure tables they give the logarithms of numbers from 1000 to 9999. While the ordinary tables give these in one opening of two pages by means of difference columns, Mr. McLaren gives all the 9000 entries independently, and so of course without difference columns. His tables consequently occupy nine openings or eighteen pages. Rapid reference to the various openings is made possible by "thumb-indexing," and for speed there is probably nothing to choose between these tables and the customary ones. There is a gain in accuracy, both because the use of difference columns is not trustworthy in the last figure, and because of Mr. McLaren's ingenious device of showing the last figure to the nearest third. Whether these tables seriously reduce the skill required for their use as compared with the customary tables we have some doubt. We think their appeal will be chiefly to those calculators who require slightly greater accuracy than the customary tables allow and who at present use five-figure tables. D. M.

Joseph Pennell's Pictures in the Land of Temples. 40 illustrations. (London: William Heinemann, 1915.) Price 5s. net.

THE sub-title to this attractive volume very well describes its contents. It runs: "Reproductions of a series of lithographs made by him in the land of temples, March–June, 1913, together with impressions and notes by the artist." The illustrations start at Taormina, proceed around Sicily—thence to Italy, and are continued in Greece. The book is dedicated to Mr. R. M. Dawkins, late director of the British School at Athens, who showed Mr. Pennell where he would find the temples. The artist says with becoming modesty that having seen the pictures Mr. Dawkins expressed the opinion that they had "something of the character and romance of the country." It is unnecessary here to praise the work of so distinguished an artist; it is enough to say that the pictures convey just the impression which the temples made upon Mr. Pennell: "the great feeling of the Greeks for site in placing their temples and shrines in the landscape—so that they not only became a part of it, but it leads up to them."

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 Continuous Spectra of Gases.

IN spectroscopic literature there are many casual references to a continuous background in the vacuum tube spectra of various gases, such as oxygen, chlorine, etc. Usually these observations appear to have been confined to the visible region, and I can recall no comments on continuous spectra in the ultra-violet except in the case of hydrogen. Schniederjost (*Zt. f. Wiss. Phot.*, 1904, p. 265) and Friederichs (*Bonn Diss.*, 1905) observed such a spectrum at low pressures, which extended to a wave-length of about 2100. The latter attempted to use the uncondensed discharge through a small capillary tube at about 2 mm. pressure as a source for the photography of absorption spectra, but found that the results were unsatisfactory, even with exposures varying from twelve to twenty-four hours.

In photographs of the hydrogen spectrum obtained with a large two-prism quartz spectrograph I have frequently observed this continuous spectrum. Although the resolving power of this spectrograph in the extreme ultra-violet is greater than that of a five-inch grating in the first order, there is no evidence of resolution into lines or bands. The spectrum appears to be uniformly continuous, and it seems likely that its gradual fading out in approaching the wave-length 2100 is due rather to the absorption of the thick quartz system than to the lack of these wave-lengths in the emitted light. It appears to be due to pure hydrogen, for successive improvements in purity due to the removal of oxygen, water vapour, and nitrogen cause no noticeable change; nor does the addition of a trace of oxygen to hydrogen previously freed from that gas so far as possible cause any appreciable difference.

It seems very unlikely that a continuous spectrum can arise from free vibrations within the atom or molecule, hence it has been usually ascribed to molecular collisions. In comparing different gases at the same pressure, the number of collisions would depend mostly on the mean velocity of the molecules, so that the number of collisions would rapidly diminish as the molecular weight increases; hence we might expect that the continuous spectrum of a light gas would be stronger than that of a heavier gas. This was found to hold good for hydrogen, helium, and neon. Photographs were obtained of the spectra of these three gases in vacuum tubes prepared by Hilger. The pressure was about the same in all. With a two-minute exposure, the continuous spectrum of hydrogen was very intense, that of helium about half as strong, and that of neon about one-third as strong. They all extended to about the same limit—that set by the transparency of the quartz. In all these cases the uncondensed discharge of a medium-sized induction coil was used. The introduction of a condenser almost completely obliterated the continuous spectrum. When a condenser is used the radiation probably comes from dissociated ions, with free periods little disturbed by molecular collisions.

Nitrogen, krypton, and xenon did not show any continuous spectrum.

Some tests showed that hydrogen tubes may render excellent service as sources for the study of absorption spectra in the ultra-violet. It was not found advisable to use capillary tubes, or to work at such low pressures as Friederichs did. The best results were obtained with end-on tubes, from 5 to 10 mm. in diameter and about 30 cm. long, with quartz windows, and at pressures in the neighbourhood of 5 mm. The necessary exposure varies from five minutes to an hour, according to the width of the slit, the absorptive power of the medium, etc. I have obtained a beautiful photograph of the absorption spectrum of benzol vapour with fifteen minutes' exposure.

E. P. LEWIS.

University of California (Department of Physics), Berkeley, California, May 18.

The Relation between Chromosomes and Sex-determination in "Abraxas grossulariata."

IN a paper on this subject in the *Journal of Genetics* (vol. iv., June, 1914, p. 1) I gave evidence that in a strain of *A. grossulariata* which I have bred for several years two kinds of eggs are produced, having respectively twenty-eight and twenty-seven chromosomes. Since the somatic chromosome-number is fifty-six in the male and fifty-five in the female, it seemed evident that the eggs with twenty-eight were male-determining, those with twenty-seven female-determining. In this strain some families in each generation consist entirely of females, so it was hoped to prove the correctness of the conclusion with regard to sex-determination by finding that in families consisting entirely of females all the eggs contain twenty-seven chromosomes. I have now examined the eggs of several such families, and find, contrary to expectation, that the equatorial plate of the inner polar spindle contains twenty-eight chromosomes about as frequently as twenty-seven. The new material confirms the observation that twenty-seven occur in one spindle and twenty-eight in the other, but it seems to make it certain that the presence of twenty-eight chromosomes in the inner spindle does not necessarily cause the production of a male—at least, in the strain which produces all-female families. A possible explanation of the anomaly is that in all-female families a chromosome is eliminated at a later stage, but at present I have no direct evidence for this. I have material preserved in the hope of testing this suggestion, but the investigation is likely in any case to be a lengthy one, and circumstances may prevent my continuing it for some months. I therefore make this short statement of the facts as at present known, in order that it may not be assumed that the existence of male- and female-determining chromosomes has been finally demonstrated in Abraxas.

LEONARD DONCASTER.

Zoological Laboratory, Cambridge, June 7.

Cavities due to Pyrites in Magnesium Limestone.

IN some districts it seems that iron pyrites formed an important constituent during the deposition of the Magnesium Limestone—not only in the north of England, but in America also in some of the Magnesium Limestones of the Cambrian age.

The Durham beds at Fulwell Hill Quarry give us ample evidence of this, as regards the English beds, by their very numerous cavities, the shape of which, which cannot be attributed to anhydrite, affords the clue. Unless carefully sought, the salts of iron are not noticed, nor are ferruginous band-stains conspicuous or frequent.

Some years ago I obtained specimens from the Roker Cannon-ball bed; some of them, recently placed in the Jermyn Street Museum, have been examined by Mr. A. F. Hallimond, the assistant-curator, who has labelled them "pseudomorphous after mispickel." These, however, were formed on the outside of the calcareous spheres. I have also secured from the Fulwell Hill Quarry a few specimens of the concretionary structure with cavities containing limonite in powder. There are, however, a large number of empty cavities that apparently once contained pyrites, which are free from the prevalent "marl" powder, from dolomite, or from any traces of anhydrite. They are from about $\frac{1}{2}$ in. up to about 6 in. in diameter, are roughly spherical, but with projecting cones; they are often decorated with strings of white calcite, though occasionally they are iron-stained (see Fig. 1).

FIG. 1.—Botryoidal mass (section) with cavity. $\times\frac{1}{2}$.

Rarely, more or less solid specimens are met with (Fig. 2) which are casts of similar cavities, due to the deposit in them of calcium carbonate. Dr. J. Lister, of the Technical Institute, Tunbridge Wells, has kindly examined these for me, and has found them to contain a notable amount of calcium fluoride, which, so far as I am aware, is a new observation.

FIG. 2.—Calcite cast of a cavity probably after FeS_2. $\times\frac{1}{2}$.

Other kinds of cavities are occasionally met with in the concretions of these beds, but, except the so-called cells, there are no others of frequent occurrence, while these, to which I am directing attention, are found in all the beds, both of limestone and marl. I have seen no traces of copper.

GEORGE ABBOTT.

2 Rusthall Park, Tunbridge Wells, May 12.

POISONOUS GASES IN WARFARE AND THEIR ANTIDOTES.

IN the Concise Oxford Dictionary a "Stink-ball" is defined as "a vessel containing explosives, etc., generating noxious vapours, used formerly in naval warfare and still by Eastern pirates." The Germans have shown the world how science may be degraded in its application to the purposes of the pirate, and our military commanders have now to deal with a new weapon previously unheard of in the field. Steps have already been taken to provide protection for our men, but a survey of the whole question of the composition and the properties of the gases which have been or are likely to be used may be of service at the present time.

The chemical laboratory would be able to provide a very large number of offensive and poisonous gases and vapours, but for practical purposes they would be limited to those which present the following qualities: (1) they must be much heavier than atmospheric air; (2) they must be producible in large quantity in the form of a portable liquid or solid, which in its turn will evaporate rapidly from the containing vessel or otherwise so as to produce the gas; (3) they should not be excessively soluble in water, or much would be lost in rolling over moist ground.

In the newspaper accounts from eye-witnesses of the cloud of gas sent out by the enemy it has several times been described as presenting a reddish colour. If this statement is based on correct observation it is certain that the gas used on these occasions must have contained either bromine or peroxide of nitrogen, both of which have an orange-brown colour. It seems improbable that oxides of nitrogen would be used on account of the cost in the form of nitric acid or nitrate from which they must be produced. Bromine, however, is made from the salts in the Stassfurth deposits, and from this source up to the outbreak of war much of the bromine and bromides of commerce was obtained. Bromine is at common temperatures a liquid, but it evaporates very easily and produces a vapour which is about five-and-a-half times heavier than air. Probably the amount of bromine available would be insufficient for the production of the enormous quantities of vapour required in these operations if used by itself, but as the whole object of manufacture in the present case is not the production of pure bromine but of something that will suffocate, the material used may consist essentially of the closely allied element chlorine, accompanied with a quantity of bromine sufficient to account for the colour.

At ordinary temperatures chlorine is a pale-green gas which is about two-and-a-half times heavier than air. The gas was discovered by the Swedish chemist Scheele in 1774, and has been used for bleaching purposes since the end of the eighteenth century. It acts rapidly on nearly all metals if moist, but when free from water it does not attack the surface of iron, and as it is easily reduced by compression to a liquid, it has been produced commercially in very large quantities for many years past in the liquid state and preserved in iron bottles. There can be little doubt that the gas from which our men have been suffering is sent into the trenches in such cylinders. The gaseous chlorine which escapes from them on simply opening the tap, whether or not it is accompanied with bromine, is quite sufficient to account for the suffering and death which have been the result of getting the gas into the lungs, but other volatile substances have been suggested as possibly available. Thus phosgene, a compound of carbonic oxide and chlorine, is a heavy gas about three-and-a-half times heavier than air, easily liquefiable and easily vaporisable from the liquid, which is a commercial article produced in Germany on a fairly large scale. Sulphur dioxide, often erroneously called surphurous acid, is familiar as the product of burning sulphur, and being liquefiable readily it may be seen in the liquid form in glass siphon bottles in every chemical laboratory.

The chlorides of sulphur, phosphorus, and arsenic are also very irritating and poisonous. The only reason for supposing that these compounds might be employed is provided by a communication from Warsaw which appeared in the *Times* of June 5, in which it is stated that the Germans had been burning straw on which a white powder resembling salt had been sprinkled. The dense smoke carried by the wind over the Russian lines is stated to have produced symptoms similar to those reported from France in the case of victims of suffocation from what is believed to be chlorine or a mixture of chlorine and bromine. The white powder used against the Russians probably contains one of the chlorides mentioned above, which might be made portable by admixture of common salt. The statement in the *Times* that the powder is believed to be some easily-made compound of *chloral* is obviously a misprint.

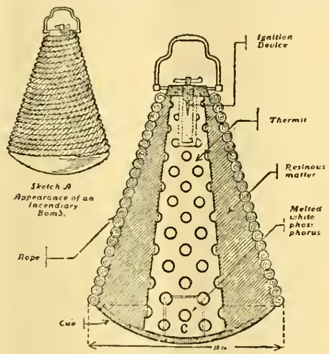
Fortunately all these fumigating agents agree in one particular. They can be absorbed and therefore stopped by passage through or over a strongly alkaline substance to which may be added, especially in reference to chlorine or bromine, a proportion of sodium hyposulphite (thiosulphate), the familiar "hypo" of the photographer. It is important to notice that a strong alkali is necessary and in layers sufficiently thick. When the ordinary housekeeper speaks of "carbonate of soda," the salt known to the chemist as *bi*carbonate is always intended, and this is almost useless.

The masks or respirators supplied to the troops consist of material saturated, though not dripping, with a *strong* solution of common washing soda (the carbonate) mixed with an equal quantity of hyposulphite, to which has been added 2 or 3 per cent. of glycerine to keep the whole damp. A very good material would also be the granular mixture of lime and caustic soda, known in every chemical laboratory as "soda-lime." This would have to be wrapped up in gauze and would not require to contain glycerine.

Many well-intentioned efforts have been made by private persons to supply their soldier friends with respirators made of gauze or muslin containing a receptacle filled with cotton waste saturated with an alkaline solution. Most of these attempts are not only imperfect but really dangerous to the men by leading them to consider themselves protected when practically there is no protection. The pads saturated with alkali are often much too small, and the cotton padding has not been secured in position by proper quilting or otherwise. Moreover, the most efficient solution has not been used. The official protectors take the form of a hood which covers the head and afford a complete protection against the gases, even when concentrated. As they are now being sent to France daily in very large numbers it is to be hoped that the directions of the War Office recently issued will be attended to and no more respirators of other types, either home made or manufactured without official sanction, will be sent to the Front.

It must not be forgotten, however, that the efficiency of all these contrivances is limited, and in the event of being exposed to several successive doses of gas the material ought to be washed in clean water and then recharged with the original chemical mixture. A supply of liquid is now furnished to the men in the trenches.

A question has arisen in connection with the idea of the possible use by the enemy of bombs containing poison, to be dropped by Zeppelins or other aircraft. In the event of such occurrence the best course would be in the first instance to



SECTION OF INCENDIARY BOMB

(*a*) The bomb, as a rule, is conical, of 10 in. diameter at the base, corded round, and has a metal handle at the apex (see A). (*b*) The base is a flat cup, on to which a pierced metal funnel is fitted, having the ignition device and handle fitted at the top. (*c*) The funnel is generally filled with Thermit, which upon ignition generates intense heat, and by the time of the concussion has taken the form of molten metal of the extraordinary high temperature of over 5000° F. The molten metal is spread by the concussion. (*d*) Outside the funnel is a padding of a highly inflammable or resinous material bound on with an inflammable form of rope. The resinous material creates a pungent smoke. (*e*) There is generally some melted white phosphorus in the bottom of the cap, which develops nauseous fumes. (*f*) In some cases celluloid chippings are added and occasionally a small quantity of petrol.

close all the windows and doors of houses in the neighbourhood. Should the smell of chlorine be perceived indoors, a cloth wetted with strong solution of ammonia should be waved about in the air. This would produce a harmless white smoke consisting of sal-ammoniac, and this, even with excess of ammonia, would produce very little if any damage to furniture, etc. With regard to wounds produced by shrapnel or other projectiles containing phosphorus, it is improbable that any of the element would escape combustion in the air. The mischief is caused by the phosphoric acid produced being carried into the tissues, and for this dressings made slightly alkaline with carbonate of soda should be used till all acid has been removed.

The chief result of air raids so far has been the production of fires, and a timely warning has been issued by the British Fire Prevention Committee. As the committee points out, fires are not usually caused by the ordinary explosive bomb. When fire occurs it is due to open lights or fires in the house or to broken gas or electric mains. The incendiary bomb is, however, designed to produce a fierce fire in itself. The accompanying diagram shows the construction of one of the ordinary types of these missiles.

The fumes from such bombs contain a large quantity of phosphoric acid, and when inhaled produce violent coughing, but fortunately they would be completely stopped by a wet cloth. Thermit, in its ignition, produces such a high temperature that the timbers of a house would be certainly inflamed if struck, but when the first burst of flame is over the extension of the fire would proceed in the manner of fires originating otherwise and would have to be dealt with by the fire brigade in the usual way. In the meantime, every house in a threatened area should be furnished with buckets and baths full of water ready drawn to be applied as quickly as possible, in quantity as large as possible, in case of necessity.

W. A. Tilden.

VISIBILITY.

THE factors which determine the ability of the eye to distinguish an object from its background are not very well known for many of the conditions met with in practice. Our practical experience has taught us that if we wish to see properly under any given condition, the illumination must not be less than a certain amount, and we have been content to provide the necessary illumination without having any very clear idea what are the aids and hindrances to good seeing. A discussion on some aspects of the subject of visibility was initiated at the Illuminating Engineering Society, on April 27, by Messrs. Paterson and Dudding, of the National Physical Laboratory; and many speakers made interesting contributions to it.

Several fields of investigation disclose themselves in connection with the subject, and are mainly concerned with cases in which objects become difficult of discernment. For instance, the conditions required to render troops or other objects invisible to the enemy is a matter which at first sight may appear simple, but if all that is said is true, the problem is a complicated one, and would justify thorough research into it.

It has been stated that if a donkey and a zebra are located in a distant field (and remained there to be observed) the zebra would become invisible long before the donkey. This effect was discussed in an interesting article by Col. F. N. Maude in *Land and Water* for January 30, in which he gave an incident from practical experience of a regiment with pipeclayed belts and accoutrements being invisible by the side of another regiment which had equipment of a more uniform nature.

The question of the visibility of distant faint sources of light at night is the simplest form in which the problem presents itself, because first, the contrast between the light and its background is very great, and secondly, because the object viewed is below the resolving power of the eye (about one minute of arc), and therefore the dimensions of the object viewed have not to be considered. The visibility of such point sources of light is inversely proportional to the square of the distance of the observer from them, and directly proportional to their candle-powers. Their visibility becomes an important matter at sea, since the navigation of ships so as to avoid collision depends almost entirely on them. A practical working visibility is 1·6 candles at two sea miles, whether the light be red, green, or yellow. There is a very marked difference, however, in the relative behaviour of these lights to oblique vision. To normal people a green light will appear some five times brighter when viewed obliquely than when viewed directly, but a red light acts in exactly the opposite way. If we place a point source of green light in a dark room so that its visibility from the position viewed is equivalent to about 0·01 micro-candle at a metre, most observers will pick up this light when looking in some other direction and be quite conscious of its presence, but no sooner does one look towards it than it is gone. A faint red light, on the other hand, cannot be picked up by oblique vision at all, but when an observer has finally discovered it by direct vision he is impressed by how very visible it is. If he glances to one side, however, it disappears. The colour of faint lights is not distinguishable by oblique vision.

Under favourable laboratory conditions of threshold visibility it is calculated that the energy which is just sufficient to stimulate a single element of the retina of the dark adapted eye is at the rate of about 10^{-15} watt.

The question of the visibility at night of objects of finite size is not so simple. The problem occurs in a practical form in the showing-up of an obstacle by a motor headlight, such, for instance, as a pedestrian on the road ahead of a car. Such objects subtend angles well above that of the resolving power of the eye, and there is no justification for assuming that their visibility follows the same simple laws which hold for point sources of light. The experiments show in effect that the visibility of objects subtending angles up to about ten minutes of arc follows the same law as for point sources, viz., the brightness must be inversely proportional to the square of the distance, but that for objects above this the brightness is proportional simply to the distance. It is the larger size of objects which have generally to be discerned when driving at night, and it therefore follows that for equal visibility at twice the distance the equivalent candle-power of a headlight must be increased eight times, and not sixteen times, as would be the case if the inverse square law held. Thus it follows that the useful range of a motor headlight is proportional to the cube root of the intensity of the beam.

The visibility of objects viewed in the presence of glaring lights is a matter which has been much discussed, but the reason for the discomfort and annoyance which is felt when one has a light in one's eyes is rather obscure—except in such gross cases as the dazzle produced on the dark adapted eye by motor headlights. Experiments show that at ordinary illuminations it is very difficult to detect by measurement any diminution of ability to see detail in the presence of bright lateral lights, although there is little doubt about the discomfort caused by them. When, however, the surface brightness of the objects to be distinguished is very low there is, when lateral lights are present near to the object, a marked falling off in the ability of the eye to distinguish the slight contrasts which exist over such surfaces, and detail appears in consequence obliterated. A room viewed under these conditions might have to the eye somewhat the appearance of an under-exposed negative in which only the high lights and strong contrasts show up. It cannot be said, however, with certainty that herein lies the evil of glaring lights, and the discomfort experienced with them may very well be psychological in character.

The discrimination of detail in certain circumstances depends almost entirely either on shadow or on the direction of the incident light. Where the surface of an object to be viewed is uneven, but uniform in colour, the only way in which the unevenness can be shown up is by differences in the illumination of such surfaces caused by the different angles which they present to the incident light. If the unevennesses are very deep they will be shown up by the shadows which are thrown by the raised portions on to the surrounding surfaces. For instance, the embossed lettering used on some notepaper depends entirely on this action, and a sculpture in bas-relief must obviously present a very different appearance according as it is illuminated by unidirectional light at glancing incidence or by light from a large source striking it mainly at normal incidence.

The question has a wide practical application in the manipulation of self-toned fabrics, viz., unicoloured fabrics with no natural contrasts. A person doing needlework with such materials depends for the discrimination of the detailed strands of the fabric on the small shadows cast by one strand on to the next and on the varying brightness over the curved surfaces of each individual strand. Both these factors depend on the unidirectional character of the light incident on the material, and the inefficiency of thoroughly diffused, viz., indirect light, for such work is most marked. The writer has, for ten years, used indirect lighting for domestic use, and for a long time ridiculed the assertion which was often made that it was a most unsatisfactory light by which to do needlework, and particularly darning. After experiment, however, it is clear that the contention is sound, and that there is nothing so good as a unidirectional light giving harsh shadows for the discrimination of detail in needlework of all kinds. Indirect lighting, with its soft shadows, is an ideal light for domestic use, except in respect of this one particular.

C. C. Paterson.

OLFACTORY STRUCTURES IN INSECTS.

THERE is no doubt that many insects have a sense of smell, but there is great variety of opinion as to the precise location of the sense. Dr. N. E. McIndoo,[1] of the Washington Bureau of Entomology, has summed up the discrepant views in forty pages, and also in one word—"chaos." Lehmann seems to have been the first to experiment (1799), and he was led to the conclusion that the seat of smell is in the spiracles. Most of the older naturalists reached their conclusion without experimenting, and the sense of smell has been referred to at least a dozen different parts, such as the mouth, the epipharynx, the palps, the caudal styles. Of recent years, as the result of experiment on one hand and histological analysis on the other, there has been a tendency to conclude that the antennæ are the olfactory organs. The antennæ are rich in sensory structures, and their removal is sometimes followed by a negative reaction to an odour which is attractive to the intact insect. Dr. McIndoo thinks that the arguments are very inconclusive.

There are certainly many structures on the antennæ which might be olfactory—pore-plates (Lubbock's pits), pegs (Lubbock's cones), Forel's flasks, pit-pegs, and end-rods; and each of these has been claimed by some investigator as the true and only seat of smell. But in all these structures the nerve-ending is shut in by the chitinous cuticle, through which, therefore, the odour would have to pass. Another difficulty emphasised by Dr. McIndoo is in regard to the distribution of the structures above-mentioned: thus the pore-plates cannot be the exclusive olfactory structures, for they are absent in all Lepidoptera; the pegs cannot be the exclusive olfactory structures, for they are absent in many male bees, and so on. The distribution of the various antennary structures in different types does not correspond with the varied rates of response to odours as shown by these types under experimental conditions. Moreover, spiders can smell, and they have no antennæ. The author concludes that for ants, bees, and wasps, the antennæ can no longer be regarded even as a possible seat of the sense of smell. It is possible, however, that what is true of one order of insects may not hold for another.

What, then, is to be made of the experiment repeatedly performed of removing the antennæ and observing that the usual response to odours did not occur? The author's numerous experiments on Hymenoptera have shown him that if the antennæ of these insects are mutilated even a little, the behaviour becomes abnormal, and the slow reaction to odours may be due to the actual injury, not to the removal of some of the olfactory structures. Amputation of the antennæ is often fatal, and the insect is so much disorganised that its failure to respond to attractive odours does not prove that the olfactory structures are on the antennæ. Details are given in support of this useful criticism.

Where, then, is the seat of smell? Dr. McIndoo takes us back to the work of Hicks (1857), who discovered vesicles or pores on the bases of the wings and on the legs, and suggested that they were olfactory. The structures have been studied by Janet and others, as well as by Dr. McIndoo. Each is like an inverted flask imbedded in the chitin, but with a minute external pore. A fibre from a sensory cell near the inner end of the flask rises to the pore, and its cytoplasm comes into direct contact with the air and its odorous particles. These pores correspond to the lyriform organs or slits discovered by Bertkau on the legs of spiders, and subsequently studied by Dr. McIndoo. When the pores on insects' wings are covered with glue or vaseline the reaction times are greatly increased, and the rates of response in particular insects correspond with the number of pores. A drone hive bee has 2600 pores, and responds in 2·9 seconds; a worker has 2200 pores, and responds in 3·4 seconds; and a queen has 1800 pores and responds in 4·9 seconds. The author is to be congratulated on his introduction of some order into the chaos of discrepant opinions concerning the seat of the sense of smell in insects.

[1] "The Olfactory Sense of Insects." By Dr. N. E. McIndoo. Smithsonian Miscellaneous Collections. Vol. lxiii (1914), number 9. Pp. 1—63, 6 figs.

SIR A. H. CHURCH, K.C.V.O., F.R.S.

THE announcement in NATURE of June 3 of the death of Sir Arthur Herbert Church, in his eighty-first year, has been received with great regret among men of science. Sir Arthur Church was educated at King's College, London, the Royal College of Chemistry, and Lincoln College, Oxford, where he took a First in the Natural Science School. He afterwards became Professor of Chemisty in the Royal Agricultural College, Cirencester. This appointment naturally led him to devote special attention to agricultural chemistry, on which he became an authority, and at the same time to direct his attention to the chemistry of plants. He contributed memoirs on vegetable albinism; colein or erythrophyll; and aluminium in vascular cryptogams, etc., and also investigated the remarkable animal pigment known as Turacin, which contains 7 per cent. of metallic copper.

Sir Arthur Church also directed his attention to mineralogical chemistry, being the first to discover Churchite, a native cerium phosphate, and several other new minerals; and he was at one time president of the Mineralogical Society. His researches in other departments of applied chemistry seem, however, to have been influenced by his strong interest in art in every form. Perhaps few chemists know that Sir Arthur Church once exhibited at the Royal Academy, besides having very fine private collections of Japanese metalwork, Oriental and English pottery, precious stones, and Italian and Oriental embroideries. This interest in art led him to take up the study of precious stones, on which he was a recognised authority, and on which he wrote a standard work, besides publishing valuable books on English earthenware and English porcelain.

Sir Arthur Church will, however, probably best be remembered by his work on the subject of artists' pigments. In connection with the Royal Academy of Arts there is an appointment—the only one of its kind in Europe—of a professor of chemistry, whose duty it is to deliver certain lectures to the art students in training. Sir Arthur Church was appointed to this professorship in 1879, and held the post until 1911, when he decided to retire. His professorship at the Royal Academy brought him into close connection with the many chemical problems involved in painting, and led to his carrying out a large number of investigations, the results of which are summed up in his book on "The Chemistry of Paints and Painting," which has passed through several editions. This book, which is the standard work on the subject, contains—very often in a few lines—the results of long and careful inquiry and research, and has done a great deal to redeem the artist from the unfortunate position in which he was placed by the dying out of the old studio traditions, and by the flood of pigments and preparations which were due to modern chemistry, and were somewhat recklessly introduced into the artist's palette.

These researches naturally led Sir Arthur Church to make a special study of the old masters and their methods, and he was also asked to inquire into the condition of the frescoes in the Houses of Parliament, and report on the preservation of the decaying stone in Westminster Abbey. For many years he worked at these problems as a labour of love, either with his own hand, or under his personal direction, restoring and preserving the frescoes, and carrying out special researches with the view of stopping stone decay in such national monuments as Westminster Abbey. In all these problems his interest in artistic and archæological questions made him devote his special knowledge of chemistry to subjects which the ordinary chemist seldom regards as of sufficient interest to attract his attention.

Of late years he prepared for the Royal Society a classified list of papers and letters in the Society's archives, this classification being the result of much labour and research and of great value as a reference to the older work which was done in the early days.

Sir Arthur Church will be missed by all men of science who knew him, and also by his many friends, on account of his personal charm and kindness and his wide culture, which touched upon so many subjects outside the realms of chemistry.

A. P. L.

NOTES.

Among the recipients of honours conferred on the occasion of the celebration of the King's birthday on June 3, we notice the following names of men of science and others associated with scientific work:—*Knights*—Mr. C. E. Fryer, Superintending Inspector of Fisheries Division of the Board of Agriculture and Fisheries since 1903; Mr. R. R. Gales, Indian Public Works Department, Engineer-in-Chief, Hardinge Bridge, Sara, Bengal; Dr. J. Mackenzie, F.R.S., lecturer on cardiac research at the London Hospital, and author of many works on the diseases of the heart; Dr. T. Muir, F.R.S., Superintendent-General of Education, Province of the Cape of Good Hope, Union of South Africa; Mr. W. Pearce, director of William Pearce and Sons (Limited) and Spencer, Chapman, and Mensel (Limited), chemical manufacturers; Mr. E. Rigg, since 1898 Superintendent of the Operative Department of the Royal Mint; Dr. W. N. Shaw, F.R.S., director of the Meteorological Office since 1905 and reader in meteorology in the University of London since 1907; Mr. W. Slingo, Engineer-in-Chief of the General Post Office. *Knight Commander of the Most Honourable Order of the Bath* (K.C.B.)—The Right Hon. Sir John Fletcher, Baron Moulton, F.R.S. *Companions of the Most Honourable Order of the Bath* (C.B.)—Surgeon-General T. M. Corker; Mr. E. H. Tennyson-d'Eyncourt, Director of Naval Construction, Admiralty; Mr. E. J. Cheney, Chief Agricultural Adviser, Board of Agriculture and Fisheries. *Knight Commander of the Most Distinguished Order of St. Michael and St. George* (K.C.M.G.)—Dr. W. Peterson, Principal and Vice-Chancellor of McGill University, Montreal. *Companions of the Most Distinguished Order of St. Michael and St. George* (C.M.G.)—Mr. A. W. G. Bagshawe, Director of the Tropical Diseases Bureau; Dr. D. M. Gordon, Principal and Vice-Chancellor of Queen's University, Kingston, Ontario. *Knight Commander of the Most Eminent Order of the Indian Empire* (K.C.I.E.)—Mr. W. Maxwell, Director-General of Posts and Telegraphs, India; Lieut.-Col. Percy Molesworth Sykes. *Companions of the Most Eminent Order of the Indian Empire* (C.I.E.)—Mr. A. W. Lushington, Imperial Forest Service, Conservator of Forests, Northern Circle, Madras; Mr. G. P. Millet, Indian Forest Service, Senior Conservator of Forests, Bombay Presidency; Lieut.-Col. C. H. D. Ryder, Deputy Superintendent of Survey of India. *Companion of the Imperial Service Order* (I.S.O.)—Rai Chuni Lal Basu Bahadur, First Assistant Chemical Examiner of the Government of India, Teacher of Physics and Chemistry, Campbell Medical School.

We regret to announce the death on June 5, in his sixty-eighth year, of Mr. F. H. Neville, F.R.S., late lecturer on physics and chemistry in Sidney Sussex College, Cambridge.

On account of the unfavourable state of the finances of the country, due mostly to the European war, the Peruvian Government has, says *Science*, ordered the closing of the Museum of National History and Archæology at Lima.

THE Triennial Gold Medal of the Royal Asiatic Society, presented for special eminence in Oriental research, has been awarded jointly to Mrs. Agnes Smith Lewis and her sister and collaborator, Mrs. Margaret Dunlop Gibson.

WE regret to announce the death of Mr. John Amory Travers, a past Prime Warden and a member of the court of the Fishmongers' Company, who was for twenty years hon. treasurer of the Marine Biological Association. Mr. Travers was greatly interested in scientific fishery investigations, and the work of the association had his unfailing support.

IN a note in last week's NATURE (p. 377), referring to Sir Henry Jackson's appointment as First Sea Lord of the Admiralty, it was surmised that no fellow of the Royal Society had hitherto received such nomination. Careful scrutiny, however, of a list of holders of the office, from the Revolution of 1688 down to the appointment on October 30, 1914, of Lord Fisher, reveals that there have been six First Sea Lords fellows of the society. Following are the names and dates of appointment:—The Earl of St. Vincent (1801); Sir Charles Morice Pole (1806); Sir William Johnstone Hope (1820); the Duke of Clarence (1827); Sir George Cockburn (1828, 1834, 1841); Sir A. Cooper Key (1879).

THE annual general meeting of the Society of Chemical Industry will be held at the Municipal School of Technology on July 14–16. Prof. G. G. Henderson, president of the society, will deliver an address, and the papers to be presented include "Research and Chemical Industry," Dr. M. O. Forster and Dr. C. C. Carpenter; "Legislation and its Effect on Chemical Industry," Prof. H. E. Armstrong; and "Chemical Engineering," Dr. G. T. Beilby.

THE Paris correspondent of the *Times* reports that the Osiris prize of 4000*l*., which the Institute of France gives every three years as a reward for the most remarkable work or discovery in science, art, letters, or industry, was awarded on June 2 jointly to Profs. Widal and Chantemesse and Dr. Vincent, of the University of Paris, whose names are connected with the development of anti-typhoid vaccination. As the Osiris prize can only be given to Frenchmen, the institute decided to award a special prize to Sir Almroth Wright, who gave the world this means of protection from typhoid.

PROF. F. C. COOPER, whose death on June 4, at Horsham, is announced, occupied the chair of chemistry in the University of St. John's, Shanghai. He was home on furlough, and expected to return to work last January. Originally a pharmaceutical chemist, his decided gift for teaching and lecturing led him to accept an appointment on the staff of the St. John's College in 1895. The science department gradually developed under his guidance to become one of the strongest faculties of the university, which is exercising so wide an influence in the educational work of China to-day. He was a keen advocate for the introduction of the metric system into China, and the author of several books in Chinese compiled to assist the English student of the language. His knowledge of Chinese, especially of the Shanghai dialect, enabled him to work with a thorough understanding of China's needs. His sympathy in this direction, no less than his scientific abilities and organising power, doubtless accounts for the prominent place he holds in the esteem of his Chinese pupils and colleagues.

WE learn from *Science* that the Franklin medal, the highest recognition in the gift of the Franklin Institute of the State of Pennsylvania, has recently been awarded to Prof. H. Kamerlingh Onnes and to Mr. T. A. Edison. The awards were made on the recommendation of the institute's committee on science and the arts, that to Prof. Onnes being in recognition of his "long-continued and indefatigable labours in low-temperature research which has enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude," and that to Mr. Edison in recognition of "the value of numerous basic inventions and discoveries forming the foundation of world-wide industries, signally contributing to the well-being, comfort, and pleasure of the human race." The Franklin Medal Fund, from which this medal is awarded, was founded on January 1, 1914, by Mr. Samuel Insull. Awards of the medal are to be made annually to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the institute, have done most to advance a knowledge of physical science or its applications. The present awards are the first to be made.

A SUMMARY of the weather for the spring season is given in the Weekly Weather Report of the Meteorological Office for the several districts of the United Kingdom, and combining the results for the thirteen weeks ending May 29. The mean temperature was nowhere very different from the average, whilst it was only in Scotland and the south-east of England that the sheltered thermometer rose to 80°. The rainfall for the whole period varied considerably in the different districts. The south-east of England stands alone with an excess of rainfall, the measurement being 111 per cent. of the average, the abnormal rains occurring generally in the middle of May. In the north of Scotland the rainfall was 96 per cent. of the average, in the east of England 95 per cent., and in the north-west of England 84 per cent. The greatest deficiency of rainfall occurred in the south of Ireland, where the amount was only 61 per cent. of the average, and in the north of Ireland it was 64 per cent. In the west of Scotland the rain was 69 per cent. of the average, whilst the lowest percentage of the average in any of the English districts was 76 in the south-west. The duration of bright sunshine for the spring was generally in excess of the normal; the only districts with a deficiency were the English Channel and the south of Ireland, whilst in the south-west of England the sunshine was normal.

THE REV. WALTER WESTON, who is already well known to lovers of mountain scenery from his frequent expeditions in the Alps of Japan, gave an interesting account, at the meeting of the Royal

Geographical Society on May 31, of the northern district of that region. It is an immense backbone of granite, associated in places with much more recent outbursts of volcanic materials. The older rock is carved into deep valleys and grand peaks, the higher of which rise well above the snow line, for they frequently exceed 10,000 ft. in altitude. The valleys often afford scenes of remarkable beauty, in which steep and rugged crags contrast with luxuriant vegetation, and the ice-fields above sometimes present the usual difficulties to the mountaineer. He ascended four of the principal summits, the highest of them attaining 10,430 ft. These masses of granite, into which the graving tools of nature have cut so deeply, must be vastly more ancient than the volcanoes, a few of which are still active at times, because the former, once a deep-seated, intrusive rock, must have been stripped of a thick protective covering before it could be exposed to the agencies of denudation by which it has been shaped. A parallel may be found in the Ecuadorian Andes, where the great volcanic masses, one or two of which are still active, rise from a high plateau of ancient rocks. In the Japanese Alps the flowers are often remarkably beautiful, and the traveller, as Mr. Weston found, can count on a kindly reception.

In the recently issued report of the Decimal Association for 1914 it is stated that since the outbreak of the war public interest in the metric system of weights and measures has greatly increased. Many of our manufacturers, however, still persist in using only British weights and measures in their catalogues and price lists intended for abroad, instead of quoting in terms of the units in vogue in the foreign country. It is evident from the reports of our consuls and representatives abroad that this practice has a prejudicial effect on the extension of our foreign trade, particularly in countries in which the metric system is used exclusively. That system has been legal in the United Kingdom for the last eighteen years, but comparatively little advantage has been taken of it either in internal or export trade. This is probably due to the fact that the system is not given sufficient attention in schools, and is more or less completely unknown to the majority of the trading public. The Association of Chambers of Commerce has realised that the general adoption of the metric system in this country is primarily an educational question, and has recently passed a resolution urging the Board of Education to take action in the matter. The decision of the Decimal Association to give precedence in its propaganda to the adoption of decimal coinage appears scarcely to be auspicious for the success of its metric system campaign. The decimalisation of the coinage is not an urgent matter. It will meet with strenuous opposition from interests that look with favour or at least indifference on the metric system of weights and measures, so that the idea of making such a highly controversial innovation a preliminary to the introduction of the metric system seems rather a retrograde policy.

The *National Geographic Magazine* for April contains a timely article by Miss F. C. Albrecht, illustrated by a fine series of photographs, on the Austro-Italian mountain frontiers. These admirable photographs, with interesting letterpress, give a vivid impression of the enormous difficulties which the Italian army must face in forcing its way through the Trentino.

In the June issue of *Man* Major A. J. N. Tremearne describes a new variety of head-measurer for use in anthropometry, and likely to be suitable for sculptors. It is intended to meet the prejudices of savages who do not fear to submit to an instrument of this kind so long as all the measurements can be taken from one single position. The new model has been improved under the advice of Profs. A. Keith and Karl Pearson. Those who are interested in the subject can inspect the model at the Museum of the Royal College of Surgeons.

Prof. Elliott Smith, speaking on "The Influence of Racial Admixture in Egypt" at the Grafton Galleries before the members of the Eugenics Education Society, on June 4, gave an account of the distinctive physical and cultural characteristics and racial affinities of the earliest Egyptians, and discussed the factors which determined the development of their peculiar type of civilisation. He described the various alien peoples who entered the Nile Valley at its northern (Mediterranean) and southern (Sudanese) extremities; their influence upon the physical features and mental aptitudes of the Egyptians, and its bearing upon the history of Egypt and the achievements of its people. The stimulating effect of contact with the more energetic and enterprising people of the north was counterbalanced by the retarding influence resulting from intermixture with the negroes from the south; and the fluctuating fortunes of Egypt throughout her long history was intimately related to the ascendancy of one or other of these conflicting factors.

The U.S. Department of Agriculture has just issued a pamphlet embodying the results of "an experiment in house-fly control" carried out at the Maryland Agricultural College. In this experiment it was sought to destroy, not the adult insect, but the larvæ bred in a "maggot trap," formed by an exposed heap of stable-manure placed on a specially constructed platform. This consisted of a wooden grating placed upon stout pillars standing upon a concrete floor surrounded by a concrete wall, four inches high, to retain water. All the flies in the neighbourhood resorted to the heap to deposit their eggs. None of the larvæ hatched therefrom attained to the pupation stage owing to the fact that the manure was kept saturated with water, which served to deprive the heap of air. Such as attained to full growth invariably migrated to the bottom of the heap and fell through the grating into the water. In this way it is claimed that 98 per cent. of the larvæ hatched in the heap were destroyed. Old manure was found to be unfavourable for the breeding of flies, owing to the absence of air and the high percentage of carbon dioxide and methane within the mass. Adult flies, captured as they emerged from carefully guarded breeding places, were powdered with red crayon or sprayed with rosolic acid, and liberated to test their range of migration, which was found not to exceed 700 yards.

A vivid account of the fauna and flora of the great forests and swamps of northern Queensland appears in the *Victoria Naturalist* for April by Mr. J. A. Kershaw, the Curator of the National Museum of Melbourne. In spite of rain and mosquitoes, much valuable field-work was accomplished. His account contains some interesting notes on crocodiles, fireflies, and elephant beetles, and on the "bower" of the fawn-breasted bower-bird, a specimen of which was procured for the museum.

An exhaustive and well-illustrated history of the midges (Chironomidæ) of Illinois, by Mr. J. R. Malloch, appears in the Bulletin of the Illinois State Laboratory of Natural History for May, which may be read with profit by those interested in the problem of the origin and evolution of species, as well as by students of the Diptera. The author describes the complete life-history of a most peculiar form of larva belonging to the Ceratopogoninæ, which lives in submerged logs; and he has, besides, succeeded in discovering new characters which will materially lessen the labour of distinguishing the members of this sub-family, which is always a difficult task.

Instances of discontinuous distribution are always worth recording. Hence attention may well be directed to the surprising occurrence of a gnat (*Culex hortensis*) at Logie, Elgin, which, according to Mr. F. W. Edwards, in the *Entomologist's Magazine* for May, was until recently not known outside the Mediterranean region. In 1913, however, it was recorded from the neighbourhood of Bonn. The Scotch specimen differs from its congeners from southern Europe only in having the wing-scales slightly broader, and from the common British gnat (*Culex pipiens*) in having the white bands on the abdominal segments apical instead of basal, and in having broad, flat scales on the prothoracic lobes.

Those interested in the behaviour of animals will find two suggestive papers in the *Zoologist* for May. In the first of these the Rev. H. Victor-Jones discusses the vagaries of the parasitic protozoan Kerona. Contrary to the generally accepted opinion he finds that all three species of Hydra serve as its hosts, and, further, his experiments seem to show that when food is withheld from the Hydra the parasites migrate with impunity to the cœlomic cavity, "wandering in and out with safety." Thus, he points out, Kerona can no longer be regarded as a strictly Ecto-parasite. Another interesting point raised in this paper is the nature of the stimulus which apparently controls the migrations of Kerona from the outside to the body-cavity. It would seem that the guiding factor in this migration is the search for food, from which the author infers that after all Kerona may have to be regarded as a commensal rather than as a parasite. In the second paper Mr. H. N. Milligan contributes some observations on the behaviour of a captive rockling (*Motella mustela*), which would seem to be one of the most timorous of fishes. The introduction of some common gobies into the tank, of which it originally was the sole occupant, caused a striking change in its habits, marked by an obvious mistrust of the new-comers. The author's description of the association, which gradually manifested itself, between the movements of its fellow-captives and the advent of food, which always caused them to display the most extreme excitement, furnishes another example of the way in which instinctively nervous animals overcome groundless fear as a result of experience.

A new edition of the Hand-list of Tender Monocotyledons—excluding orchids—cultivated in the Royal Botanic Gardens, Kew, has just been issued For convenience of reference the plants are arranged in alphabetical order, which is a departure from the previous edition, but will no doubt be found more practical and serviceable, though perhaps somewhat less instructive at first sight. The present list contains many more names than were in the original edition of seventeen years ago, partly owing to accessions from Central and South America, South-east Asia, and especially tropical Africa, and partly also because the more important natural families of Monocotyledons have been the subject of careful study by botanists, which has resulted in the more exact determination of the plants now under cultivation. The Kew hand-lists are of so much value to horticulturists that it is to be hoped it will soon be found possible to bring the other hand-lists up to date.

Moultonia, a new genus of Gesneraceæ, forms the subject of an interesting paper by Prof. Bayley Balfour and Mr. W. W. Smith in No. xl., vol. viii., of Notes from the Royal Botanic Garden, Edinburgh. As in some species of the genus Streptocarpus and in Monophyllea, only a single leafy organ is present, but the inflorescence is epiphyllous. The plant is considered to show a permanently embryonic vegetative state, the stalk and lamina being outgrowths from the primitive protocorm of the plant. The protocorm possesses great meristematic activity, and gives rise in due course to the flowers. The plant is thus without stem, and probably without a true root. All that is developed is a cotyledon-like lamina from one end of the protocorm, which becomes the assimilating organ, and a long stalk which is hypocotylar in nature and probably gives rise to adventitious roots. An interesting comparison is drawn between this plant and the different types of Streptocarpus, and also with *Chirita hamosa*, where the flowers arise in a line on the upper surface of each petiole.

Some time ago the mathematical paradox referred to by "A. S. E.," in Nature of May 27, p. 345, was put in a much more striking form: "Suppose the earth spherical, and a cable laid along the equator in contact with the surface; its length would be about 25,000 miles. If the cable were everywhere 6 ft. from the earth's surface, how much longer would it be?" Led up to by talking about allowances for curvature in road-making, and by measuring circumferences of plates, etc., this is a good "catch" to try on your cleverest nephew at Christmas. Letters sent to Nature on the subject give correct explanations of different kinds (for the case of the circle), but they seem to miss the essential point, namely, that we are dealing with the difference of two values of a linear function of a variable. As a contrast, let us suppose the depth of the sea increased an inch; this would mean the addition of many millions of tons of water. There are two principal reasons why results of this sort are truly paradoxical to most people, in the sense of being unaccountably surprising. Comparatively few people really appreciate the properties of the simplest mathematical formula; and, apart from this, it is a difficult thing to make a mental scale of magnitude of any great extent. Thus observation and calculation convince us of the fact that if the earth were placed at the centre of the sun, the moon's orbit relative to the earth would be inside the sun; but it is very difficult for people who are not astronomers to realise this in the same sense as they realise that a pea will go into a thimble.

In an address delivered before a joint meeting of the Franklin Institute and the Philadelphia Section of the American Institute of Electrical Engineers in January last, Mr. W. S. Murray, consulting engineer to the New York, New Haven, and Hartford Railway Company, reviewed the conditions affecting the success of main-line electrification. The experience of that line, which possesses 75 miles of four to twelve track electrified route are largely drawn upon. The system in use is the high potential single-phase with contact wire, and as it has enabled the coal bill of his line to be reduced 50 per cent., Mr. Murray considers it superior to its rivals. He gives a long series of statistics of the amount of power generated at the central station, and the cost of operating the passenger and goods services and of maintaining the line and equipment. From these we gather that the total cost per train mile for power, engine-house expenses, locomotive supplies and repairs, and train men is 73 cents, and per 1000-ton mile 47 cents. The address is reproduced in the May number of the *Journal of the Franklin Institute.*

The Bureau of Standards of the Department of Commerce at Washington has just issued a "circular" on "The Composition, Properties, and Testing of Printing Inks." This is a pamphlet of thirty-five pages, and deals concisely with various oils, pigments, driers, and formulæ for the making of printing inks. The relationship of the ink to the paper is also considered, from the highly absorbent papers used for newspapers to the coated and wholly non-absorbent papers used for illustration work. In the former case the vehicle may be a non-drying oil, but where there is no absorption it is necessary to employ a quickly drying or hardening medium, though it must not dry on the formes or rollers. One of the most useful sections of the pamphlet describes the "ink requirements of the Government printing office" for web-press ink, job black ink, flat-bed black ink, and half-tone black ink, with the methods of making the practical tests. Actual printing tests under definite conditions are preferred for practically finding the qualities of various inks, because "if the article does all that is required of it, its composition is of minor importance." But analytical tests are valuable for ascertaining the causes of trouble in printing, the permanency of pigments, and so on, and, in the opinion of the director, there is room for a considerable extension of such work. The circular is a valuable addition to the technology of the subject.

Owing to the enormous quantity of oil which is now carried in bulk annually across the oceans, considerable interest is attached to a paper on the evolution of the oil tank-ship, read by Mr. H. Barringer at the Institution of Petroleum Technologists on May 28. Although there is no written history of the earliest bulk oil-carrier, the Chinese Newchang junk, originally built for the carriage of water in bulk, and afterwards used for oil, must be amongst the earliest examples of this class of vessel. The Chinese junk is provided with an expansion trunk, as in the modern steamer, the objects being to provide for the expansion of the oil caused by rise in temperature, and to keep the main hold always full, thus minimising the wash of oil due to the movements of the vessel. For some years, vessels carrying 6000 to 7000 tons were favoured by owners, but lately the tendency has been to build larger ships; in 1912 to 1914 the average was about 9000 to 10,000 tons, although ten vessels each of 15,000 tons capacity were built. There are now about 434 bulk-oil, ocean-going steamers afloat, representing a total gross tonnage of 1,637,000. One hundred and ninety-two of these vessels are fitted for burning liquid fuel. In the years 1910 to 1914 inclusive, 166 vessels were put into commission, having a total gross tonnage of 800,000, the output in these five years being equal to nearly half the tonnage now afloat. In addition to these steam vessels there are fifty-seven sailing ships representing 99,788 gross tons. Many of the recent ships are constructed on the Isherwood principle of longitudinal framing. The oil-pumping arrangements are very complete. The capacity of each of the four duplex pumps fitted to recent steamers is 300 tons per hour; these pumps are designed to deliver oil against a pressure of 250 lb. per sq. in., and have enabled 15,200 tons of liquid fuel to be discharged in $31\frac{3}{4}$ hours through one 14-in. shore line.

Information has been received at the Meteorological Office from the seismological observatory at Eskdalemuir of the record of a large earthquake which occurred on June 6, at about 9 p.m., G.M.T. The computed position of the epicentre of the disturbance is latitude 10° S., longitude 60° W.; that is, in Brazil.

Messrs. Witherby and Co., who are to publish "The Birds of Australia," by Mr. Gregory M. Mathews, announce that the subscription list will close on June 30, so that orders should be placed immediately, as no new subscribers will be accepted in the British Islands after that date. The complete work is compiled from all published sources and from the author's own observations, together with those of a large number of field-naturalists in all parts of Australia. The edition is strictly limited to 260 numbered copies, more than two hundred of which have been already taken up.

OUR ASTRONOMICAL COLUMN.

PARALLAXES OF FOUR VISUAL BINARIES.—The parallaxes of four visual binaries have been determined by Mr. F. Slocum from photographs taken with the 40-in. refractor of the Yerkes Observatory, the values of which are given in the *Astrophysical Journal* (vol. xli., No. 3). The following is an abridged summary of the results:—

Star	Spectrum	Proper motion	Relative parallax	Probable error
		"	"	"
42 Comæ ...	F5 ...	0·49 ...	+0·058 ...	±0·008
η Coronæ ...	G ...	0·23 ...	+0·073 ...	0·014
70 Ophiuchi..	K ...	1·13 ...	+0·212 ...	0·007
85 Pegasi ...	G ...	1·30 ...	+0·084 ...	±0·010

The author then gives two further tables showing the absolute parallax, cross velocity, motion in space, mass, and luminosity of each system, together with the elements of the orbits, the radial velocities, and the magnitudes. The following abridged table indicates some of the above results:—

	Absolute parallax of binaries	Period in years	Mass of system
42 Comæ ...	+0·062	25·3	1·97
η Coronæ ...	0·076	41·6	0·94
70 Ophiuchi ...	0·216	87·9	1·22
85 Pegasi ...	+0·088	25·4	1·21

ABNORMAL VARIABILITY OF MIRA CETI.—The variable *o* Ceti, or Mira, is perhaps the most interesting of all known variables, and its large range of magnitude, varying from a bright naked-eye star to invisibility, renders it an object of fascinating study. It is, however, a *variable* variable, for not only does its period of waxing and waning oscillate from about 320 to 370 days, but the brightnesses at maxima or minima do not always reach the same values. Sometimes the magnitudes reached at maxima are estimated to be from 1·2 to 3·9, and the minima magnitudes vary from 8·0 to 9·5. It is quite possible that these minor changes are themselves periodic. A note on the recent behaviour of this star is printed in the *Memorie della Soc. degli Spett. Italiani* (vol. iv., ser. 2, March), and in it Sig. A. Bemporad refers to the recent abnormal maximum. He points out that at the last maximum, which occurred in the present year, the variable only reached magnitude 4·2, while the previous maxima in 1910, 1911, and 1914 were 3·3, 3·5, and 3·6 respectively. Unfortunately, no data are given for the years 1912 and 1913, for it could then be seen whether there had been a gradual diminution of the brightness at maximum during those years. The values for the amplitudes (in magnitude) of the light waves, estimated from a minimum to a following maximum, are given by him as follows:—

1910–11	1911–12	1913–14	1914–15
m.	m.	m.	m.
6·2 ...	6·2 ...	6·0 ...	5·2

and these values show a flattening out of the curve, especially during the last period. The intervals in days occupied from a minimum to the following maximum, for the same years as given above, were 118, 129, 122, 104, and these values again show the abnormality of the recent maximum.

Another communication on recent observations of this variable appears in *Astronomische Nachrichten*, N. 4801. This is contributed by Prof. A. A. Nijland, who gives a bright curve extending from July, 1914, to March of the present year. According to him, the minimum occurred on October 10 of last year and the maximum on January 29 of the present year, its magnitude not exceeding 4·0 with the naked eye on the latter occasion.

REPORT OF THE BOMBAY AND ALIBAG OBSERVATORIES.—The director of the Bombay and Alibag Observatories, Mr. N. A. F. Moos, presents his report on the conditions and proceedings of these observatories for the year ending December, 1914. As the work is chiefly routine, namely, time, meteorological, and magnetic observations, which vary little from year to year, the report is very similar to those of former years. It shows that the observatory has been free from plague or any other infection during the past year, although a severe epidemic raged in the town during the winter months up to the middle of May; that the time-balls were dropped successfully on almost every occasion; that the magnetic instruments are in good working order; that the Milne seismograph recorded forty-seven earthquakes during the year, one of which was a great disturbance (May 26), besides several small local and other movements, etc. A long list is given of the routine operations, and it is stated that the major portion of the volume of magnetic disturbances, charts, data, and discussion for the years 1906–14, which brings up to date the data, etc., published in the magnetic volume 1846–1905, is in the press, and expected to be completed shortly. The magnetic work in connection with the programme of the Australian Antarctic Expedition was completed during the year.

THE ANNUAL OF THE NATIONAL OBSERVATORY OF RIO DE JANEIRO.—The issue of the annual of the National Observatory of Rio de Janeiro is the thirty-first of the series, and, like its predecessors, contains a large amount of useful tables and data. The volume is divided into four parts, the first dealing with the calendar and astronomical data for the present year, the second composed of tables, etc., for the reduction of astronomical observations, the third giving a synopsis of the metric system, different units, and physical constants, and the fourth and last part concerning geo-physics and climatology, tables of the tides for numerous places forming an important portion of this section.

AGRICULTURAL RESEARCH AT THE ROTHAMSTED EXPERIMENTAL STATION.[1]

THE Rothamsted Experimental Station was for many years entirely supported by the generosity of its founder, the late Sir John Lawes, but latterly, as one of the institutes for agricultural research to which grants are made from the Development Fund, has been able considerably to extend the scope of its operations. Thanks to this assistance and to numerous private benefactions, the station has been able to enter into occupation of the Home Farm at Rothamsted, giving it scope for the desired increase in its field-work, and of a range of new laboratories, now nearing completion, that will compare favourably with those of any other institution of a similar nature. The day is past when a chemist alone could supply all the science an agricultural experiment station could be supposed to need; chemistry itself has become differentiated, and some of the agricultural problems demand the specialisation of an organic as others of a physical chemist over and above the purely analytical work that still constitutes so much of the routine of such a station. Biological questions are also involved, so that we see on the enlarged staff of the Rothamsted Station bacteriologists, botanists, and a protozoologist.

Dr. Russell, in recording the pulling down of the old laboratory wherein for sixty years so much of the pioneer work of the science has been accomplished,

[1] Lawes Agricultural Trust. Rothamsted Experimental Station, Harpenden. Annual Report for 1914. (Harpenden: D. J. Jeffery, 1915.)

takes occasion to discuss the bearing of the work of a research station upon the development of agriculture. He maintains that its function is to obtain knowledge that the corps of teachers and experts now in the country can utilise. "Before the expert adviser and the teacher can do their work satisfactorily it is evident that definite systematic knowledge must be obtained of the subject with which they have to deal. Until this has been done much of their teaching must be purely conjectural, and may even be unsound—the history of the subject is full of illustrations in point. The only safe foundation on which their work can be built up is sound accurate knowledge gained by systematic investigation."

This appears to us very necessary doctrine; the State has now endowed Rothamsted so that it becomes subject to official criticism as to whether it is returning value for its money, and official criticism always likes to take its cue from the practical man. Yet much of the best work of Rothamsted must remain not merely unappreciated by, but unintelligible to, the practical man; the real test of its value must be whether it is moulding the opinion and rendering more accurate the advice of the teacher who is dealing directly with the farmer. To take a case in point: one of the commonest questions addressed to the scientific man by the farmer is whether he should lime his land, how much should be put on, and whether quicklime or carbonate. The first part of the question admitted of some sort of answer from analysis, though the chemist who began by determining the amount of calcium dissolved out of the soil by acid (a practice by no means extinct) arrived at most misleading results. Later the chemist began to determine the carbonate in the soil as a measure of the necessary base to supply which is the function of quicklime or carbonate, and latterly refined methods of analysis were devised to pick up the trace of carbonate which in many soils makes all the difference between fertility and poverty. Still, there were many dubious cases left; nor were they quite cleared up by attempts by means of litmus, etc., to determine whether the soil was neutral or acid.

In a set of papers abstracted in this report Hutchinson and MacLennan have practically cleared up the difficulties by attacking the problem from the chemical and biological side simultaneously. As an outcome they have devised an analytical process which proved sufficiently critical to indicate differences in the soil corresponding to the varying natural flora of parts of Harpenden Common, a non-calcareous soil verging on acidity and in places overpassing the neutral limit. These authors further were able to discriminate between the action of quicklime and carbonate of lime, so as to arrive at a rational explanation of the very different action upon the soil they occasionally exhibit. The continuous work these three papers represent would appear to a practical man to be wasted; he "knows" that lime is the remedy for sour soils and requires no research to teach him that. The shoe does not happen to be pinching him, but the time comes when some other practical man begins to wonder if his soil is sour and if he wants lime or had better try chalk or ground limestone, points on which the general maxim of sour soils requiring lime has no particular bearing So he turns to his scientific adviser, who is now, thanks to Hutchinson's and MacLennan's research, in a position to answer with some accuracy. We have laboured his point because it is typical; years and years of work of a research station, even if successful, may be required in order to modify a single sentence in a text-book, upon which, in its turn, depends the judgment of men whose function it is to advise the farmer.

To the practical man the work of a research station must always seem remote and in the air; fortunately the old field plots at Rothamsted have such an extraordinary fascination and raise such interest in the least scientific of farmers that the value of the unseen laboratory work has been also taken for granted; moreover, the new land available is being utilised for sundry temporary experiments of immediate interest to the working agriculturist.

PRESENTATION TO SIR PHILIP MAGNUS.

A DISTINGUISHED company assembled in Carpenters' Hall, London Wall, on Wednesday, June 2, on the occasion of the presentation to Sir Philip Magnus, M.P., of an address on his retirement from his position as superintendent of the technological examinations of the City and Guilds of London Institute, which he has held for the last thirty-five years, by the Association of Technical Institutions, a body representing more than ninety such institutions in the United Kingdom and in the colonies. The assembly was a fine testimony of the esteem in which he is held by all ranks of educationists for the eminent service he has rendered by speech and writings and by administrative work during a long and strenuous life. There were present, among many others, Sir Alfred Keogh, who presided, Sir Henry Miers, the Rt. Hon. Herbert Samuel, M.P., Mr. Pike Pease, M.P., the Rt. Hon. Sir Wm. Mather, Sir H. F. Hibbert, M.P., Sir Swire Smith, Sir George R. Kenrick, Sir Amherst Selby-Bigge, Sir John Struthers, Mr. Morton Latham, Prof. H. E. Armstrong, Dr. G. T. Beilby, and representatives of the Teachers' Registration Council, of the associations of directors and secretaries for education, of teachers in technical institutions, of the art masters, of Local Government officers, and of the College of Preceptors. The presentation of the illuminated address was made by Mr. J. H. Reynolds, and of the personal gifts to Sir Philip and Lady Magnus by Sir Wm. Mather. The address set forth the high appreciation of the association for the great services rendered by Sir Philip Magnus as a member of the Royal Commission on Technical Education of 1882, and for the important share which he has taken, not only in the development of technical education as a consequence thereof, but in the endeavour to place upon a sound footing the teaching of science in the secondary school and to introduce the principles and practice of manual training in all types of schools.

Reference was made in the course of the proceedings to the great value of the work accomplished by the institute under the guidance and inspiration of Sir Philip Magnus, to the help and encouragement given in the foundation of many technical institutions, to the establishment of a system of technological examinations which last year comprised seventy-three subjects attended by 56,000 students, and to the paramount necessity of more serious attention being given to the cultivation of science and to its application to industrial uses if the nation is to maintain successfully its industrial and commercial position in competition with other nations and especially with Germany. No attempts to "capture" German trade can have any possible chance of success unless they are founded on the sure basis of scientific research carried out by men thoroughly trained as scientific investigators, supported, as in Germany, by ample resources; and for this purpose it is necessary that there should be an entire change in the attitude of the English employer, from whom much more active encouragement and sympathy are needed. The course of the war has shown the enormous advantage which Germany enjoys as a result of her sedulous cultivation of science in its technical applications, and the peril in which some of our staple industries have been placed by reason of our lack of dyestuffs and other materials which are the product of her great chemical manufactories, and which could, if proper encouragement were given and suitable measures taken, be produced in this country.

THE UNIVERSITIES AND INVESTIGATION.

Most of us are perhaps a little tired of addresses by eminent people explaining that the extension rather than the propagation of knowledge should be the primary object of a university. But the most jaded appetite will find something stimulating in a founder's day address delivered at Clark University by Prof. Ralph S. Lillie (*Science*, April 16). Nowhere has the case been put more simply and directly, with greater force and less of the overstatement which is apt to defeat its own objects; nowhere has the defence of "useless knowledge" been conducted with greater cogency and sanity.

But Dr. Lillie's main object is not to establish principles to which everyone in these days pays at least lip-service, but to inquire how best they may be put into operation. What exactly should a university do to encourage research? Build laboratories, endow chairs, and try to attract the best men to fill them—such is the answer which would probably be given in this country. But American experience seems to show that something further is also needed. These things have been done on an unprecedented scale, and yet the production of work of the highest class is inconsiderable compared with that of several European countries far less lavishly equipped. Why? asks Dr. Lillie.

His answer is that the right spirit of research is lacking. He thinks that it has been too hastily assumed that the methods which have proved successful in the production of goods must be equally successful in the production of thought. The cult of the card-index, the typewriter, and the timekeeper has been carried too far; the heads of departments are overburdened with executive duties, and the demand for an appearance of strenuous activity leaves them and their subordinates no time to think.

And Dr. Lillie has a graver charge to bring. He accuses some American universities of being under the influence of a mistaken conception of democratic equality. He finds it necessary to protest against "a spirit of hostility to distinction." He quotes influential speakers to show that there is a tendency to underrate the importance of the exceptional mind and to imagine that everything can be achieved by industry without genius. He does not doubt the value of organised collaboration in the development of an investigation, but he fears that the exaggerated importance attributed to "team-methods" is apt to smother the individual inspiration from which all investigation must spring. "A university should be the stronghold of individuality," he protests in a notable phrase.

How far the diagnosis is correct it is not for a foreigner to judge, but the questions he raises have an interest beyond any immediate application. Is it really possible to do anything actively to encourage research? Will not official attempts to encourage the highest form of scientific learning have the same deadening effect as official attempts to encourage art? Can we do anything to produce a genius except avoid crushing him when he appears, and is even this negative precaution necessary? A genius is one who moulds and is not moulded by his circumstances, and, in spite of Dr. Lillie's fears, the men he wants will appear in the fulness of time when they are ready.

N. R. C.

ECONOMIC GEOLOGY OF NAVANAGAR.[1]

Mr. E. Howard Adye, as Director of the Geological Survey of Navánagar, has written a memoir of 262 pages on the economic geology of the State. A coloured lithological map, on the scale of one inch to four miles, is bound up in sections with the volume, and numerous photographic plates of rock-sections and a few landscapes illustrate the text. The rock-slices have been selected with the care that might be expected from Mr. Adye's previous work (see Nature, vol. lxxvii., p. 125), and a system of lettering indicates the various mineral constituents. The production of this handsome and well-bound memoir by the Government of a native State in India renders the portrait of the Maharaja, Jam Shri Ranjitsinhji, distinctly welcome as a frontispiece.

One of the most interesting features of the region is the wide development of a foraminiferal limestone, which was laid down apparently in post-Pliocene times, and which is now in places 1100 ft. above the sea. The name "Miliolite" has been unfortunately given to this stone, and is retained, with suitable explanations (pp. 133 and 135), by the author. The rock becomes hard and durable on exposure, and has been used with marked success for building. Great masses of "hypabyssal" acid rocks occur in the south of the State, giving rise to the bold features of the Alech and Bard Hills. Mr. Adye predicts a commercial future for the micropegmatitic and other fine-grained types (granophyres and felsites), which are capable of being highly polished, and are also serviceable as road-metal (p. 219). This series, with which a few rhyolites are associated, was intruded about the opening of the Eocene period into the widely-spread basalts of the Deccan trap. Pipe-amygdaloids (p. 56) and other types of the vesicular basic lavas are described. In dealing (p. 194) with the quality of toughness which characterises ophitic basalts, the nodular crystals of pyroxene in which the felspars are embedded are styled "plates." This is a very common slip, due to the impression given by these objects in rock-slices; but it injures the explanation given of the resisting properties of the rock. Perhaps we must not grumble at the new names proposed for altered limestones, "pindáralite" (pp. 178 and 181) for a marine rock permeated by iron hydroxide, and "ramwaralite" (p. 183) for a similar rock in which dolomite has developed. Such terms will at any rate attract interest within the State, and will thus serve one of the main objects of the book.

Mr. Adye's style has become curiously assimilated to that of certain Indian writers of English. Apart from the irregular distribution of commas, there are phrases like "sacerdotal equipments" and "revenons à nos moutons," and the statement (p. 9) that a range of hills "has hitherto remained 'without a local habitation and a name,'" which would make a stranger doubt the author's nationality. How did a hill escape a local habitation? These things, however, probably show the influence of environment on a writer who is obviously throwing his energies into the development of the country which he serves.

G. A. J. C.

[1] "Memoir on the Economic Geology of Navánagar State in the Province of Káthiáwár, India." By E. H. Adye. (Bombay: Thacker and Co., 1914.)

THE ROYAL OBSERVATORY, GREENWICH.[1]

THE *Moon's Tabular Place.*—The total number of observations made of the moon during the year ending May 10, 1915, is 107 with the transit-circle and 98 with the altazimuth, viz. :—64 in the meridian and 34 extra-meridian. Taking both instruments, observations of the moon have been obtained on 127 days during the year.

The mean error in right ascension of the moon's tabular place for 1914 is −0·876s. from meridian observations and −0·933s. from extra-meridian observations of the moon's limb, and −0·915s. from meridian observations of the crater Mösting A. The transit circle gives −0·899s. Attention is directed to the great increase in recent years of the mean tabular error of the moon's longitude. From 1883, when Newcomb's Empirical Correction was introduced into the "Nautical Almanac," the values (all reduced to the same equinox) are—

1883	″ −0·03	1899	″ −2·18
1884	−0·16	1900	−2·69
1885	−0·09	1901	−2·77
1886	−0·11	1902	−3·15
1887	+0·21	1903	−3·08
1888	+0·76	1904	−3·16
1889	−0·38	1905	−5·29
1890	−0·27	1906	−5·91
1891	+0·72	1907	−5·96
1892	+0·79	1908	−5·97
1893	−0·06	1909	−6·41
1894	−1·20	1910	−7·85
1895	−1·47	1911	−8·34
1896	−1·68	1912	−9·79
1897	−2·77	1913	−11·93
1898	−3·03	1914	−13·0

Cookson Floating Zenith-Telescope.—During the year 238 photographs have been taken, 231 for latitude groups and 7 for scale determination. From the commencement of the observations, 1911, September 7, 609 latitude plates (excluding rejected plates) have been obtained, of which 553 have been measured in the direct, and 549 in the reversed position. In addition, 24 plates taken for scale have been measured and one plate rejected.

The results obtained since the commencement of the seven years' series of observations until the end of 1914 have been discussed, and the results communicated to the Royal Astronomical Society. The value of the aberration constant obtained is 20·467″±0·006″. The observations also furnish a determination of the latitude variation, although not designed primarily for this purpose. The latitude variation derived in this way shows a satisfactory agreement with the results of the International Latitude Service, and it is hoped that a comparison of the two series of results when the Cookson results have been brought to a conclusion will throw some light upon the origin of the *z* term in the latitude variation.

The 28-in. Refractor.—Observations of double stars have been made from a working catalogue containing all known double stars showing appreciable relative motion, which are within the range of declination of the instrument. A number of other stars are included for various reasons, particularly some of those discovered by Hussey and Aitken under 2″ separation. Since October 16 M. Jonckheere, the director of the Lille Observatory, has also had the use of the instrument in connection with the catalogue he is preparing of double stars of less than 5″ separation discovered since 1905, the date of Burnham's General Catalogue, and has carried out many re-measures and verification of positions.

Thompson Equatorial.—The work with this instrument has been concentrated on stellar parallax and photographic photometry. The photographs have all been taken with the 26-in. refractor.

The programme of stars the parallaxes of which are being determined contains all those between declination +64° and the north pole which are known to have a proper motion of more than 20″ a century. Each star is photographed at times of opposite parallactic displacement in right ascension on the same plate. It is found that six such plates give a good determination. For three of the plates the first exposure is given when the star transits soon after sunset and the second exposure when it transits a little before sunrise, and for the other three the morning exposures are made first. Generally, the series of exposures will be extended over two or possibly three years, so as to avoid anything systematic in observational or instrumental conditions.

During the year ended May 10, a first exposure has been given to 238 plates and a re-exposure to 294. In the same period 234 plates have been measured and 39 in duplicate. Experience seems to show that duplicate measurement is unnecessary, it being understood that each plate contains six images of each star, three at each epoch, and that in the first measurement the plates are reversed and every image measured twice. the parallaxes of 40 stars have been determined, with an average probable error of ±0·009″, and the results will be communicated to the Royal Astronomical Society.

The determinations of photographic magnitudes with the 26-in. refractor have been made by comparing certain fields with the polar standards determined by Prof. Pickering. Generally, exposures of 6 minutes have been made on Ilford "Monarch" plates, and the limiting magnitude reached is about 14·0m. on the Harvard scale. During the year 88 photographs of this kind have been taken of the "selected areas" of Prof. Kapteyn.

Six-inch Astrographic Triplet.—The catalogue of photographic magnitude of stars down to the 9th magnitude between dec. +75° and +65° has been completed and published. It contains 5514 stars the magnitudes of which are determined with an average probable error of ±0·06m. The large field of this lens makes it very suitable for the determination of the photographic magnitudes of the brighter stars, and it is hoped to carry on this work in other declinations as opportunity offers.

Astrographic Equatorial.—The observing has consisted mainly of chart plates for the Oxford zone dec. +25° to +31°. Two exposures of 30 minutes each are given to each field, Wellington "Xtreme" plates being used on account of their speed.

The printing of vol. iii. of the Astrographic Catalogue was finished in August. This volume contains the right ascensions and declinations, as well as the photographic magnitudes, of 16,780 stars from declination +64° to the north pole deduced from the measurements of the astrographic plates.

A thorough examination of these stars for the determination of proper motion is being carried out, and in addition to the catalogues mentioned comparisons are being made with the observations of Lalande, Argelander, and others. Proper motions have been determined for the stars of Carrington's Catalogue (dec. 81° to the pole), of the Kasan Catalogue (dec. 75° to 80°), and of the Dorpat Catalogue (dec. 70° to 75°) as far as 18h. In a number of cases large proper motions have been verified by comparison of

[1] From the report of the Astronomer Royal, Sir F. W. Dyson, F.R.S., to the Board of Visitors of the Royal Observatory, Greenwich. Read at the Annual Visitation of the Royal Observatory, on June 5.

plates taken at an interval of from 15 to 20 years. The largest proper motion found by this examination is 1·0″ annually belonging to B. D. 77°, 361, a star of 9·2m. visual and 10·9m. photographic magnitude.

Heliographic Observations.—In the year ended May 10, photographs of the sun were obtained on 239 days.

The mean daily spotted area of the sun was 140 millionths of the sun's visible hemisphere during 1914, as against 8 in 1913, 37 in 1912, and 64 in 1911, thus showing the usual rapid rise from minimum.

Magnetic Observations.—The mean values of the magnetic elements for 1914 and three previous years are as follows:—

Year	Declination W.	Horizontal force in C.G.S. units	Dip
	° ′		° ′ ″
1911 ...	15 33·0	0·18549 [2]	66 52 6 (3-in. needles)
1912 ...	15 24·3	0·18548 [2]	66 51 46 ,, ,,
1913 ...	15 15·2	0·18534 [2]	66 50 27 ,, ,,
1914 ...	15 6·3	0·18518	{ 66 49 27 ,, ,, 66 51 13 (dip inductor)

The new magnetograph house appears to be perfectly satisfactory. The arrangements for maintaining constancy of temperature have so far worked well, the indication of a set of maximum and minimum thermometers showing differences of only a small fraction of a degree Fahrenheit during periods of several weeks between successive visits of the observer to the chamber for the purpose of making scale determinations.

Meteorological Observations.—The mean temperature for the year 1914 was 50·8°, or 1·3° above the average of the 70 years 1841–1910. For the 12 months ended April 30, 1915, the mean temperature was 50·2°. During the 12 months ended April 30, 1915, the highest temperature in the shade (recorded on the open stand in the enclosure of the magnetic pavilion) was 92·1° on July 1. On 21 days the highest temperature in the shade equalled or exceeded 80°. The lowest temperature of the air recorded during the same period was 22·3° on January 23. There were 36 days during the winter on which the temperature fell as low as 32·0°.

The mean daily horizontal movement of the air in the year ended April 30 was 288 miles, which is 4 miles above the average of the previous 47 years. The greatest recorded daily movement was 791 miles on December 4, and the least 75 miles on April 11. The greatest recorded pressure to the square foot was 26·3 lbs. on December 28, and the greatest velocity in an hour 55 miles on the same day. During the year 1914, Osler's anemometer showed an excess of 11 revolutions of the vane in the positive direction N., E., S., W., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during the 12 months ended April 30, by the Campbell-Stokes instrument, was 1573 out of a possible 4457 hours, giving a mean proportion of 0·353, constant sunshine being represented by 1. This is above the average amount, principally on account of a fine June and a fine September.

The rainfall for the year ended April 30 was 24·73 inches, being 0·61 inch greater than the average for the period 1841–1905. The number of rainy days (0·005 inch or over) was 171. September with 0·73 inch was the driest month and December with 6·02 inches the wettest; it was, in fact, the wettest December in the Greenwich series, and the three winter months, with 12·86 inches, the wettest winter in 100 years.

Clocks and Time Service.—The daily time signals from the Eiffel tower have been regularly observed by Mr. Lewis and Mr. Bowyer. The mean of the times as observed by Mr. Lewis is +0·026s. late on Greenwich time from 209 observations, and by Mr. Bowyer +0·043s. late from 280 observations. The difference of a quarter of a second between the Eiffel Tower signal and the time as determined by the transit circle which existed two years ago appears to have been the personal equation of the standard observer as compared with the new impersonal micrometer.

The accuracy of the time-balls at the Admiralty signal stations and of the Westminster clock is shown by the following table of the errors of the return-signals received at Greenwich.

Apparent Error of Return Signal	s.	Portsmouth	Portland	Devonport	Westminster
Not greater than	0·2	271	251	293	21
Between	0·2 and 0·5	13	12	14	28
,,	0·5 ,, 1·0	1	0	4	65
Greater than	1·0	0	0	0	74

The Westminster clock was on two occasions only found to be more than 3·0s. in error.

[2] The values given in last year's report have been increased by 20γ, arising from a redetermination of the moment of inertia of the deflecting magnet.

RADIO-THERAPY: ITS SCIENTIFIC BASIS AND ITS TEACHING.[1]

THE recent discovery that X-rays and γ rays can be defracted into spectra by the natural grating contained in the orderly structure of crystals, sets at rest the question as to the nature of these radiations. They are of the same nature as light-waves, but of very much higher frequency—from 10,000 to 100,000 times as high.

The certitude of the identity of these three classes of radiation leads to issues of much importance to medical science. For medicine had for many years been invoking the aid of the mysterious X and γ rays without in the least knowing what these agents were. It now turns out that they are physically identical with light. This fact secure, medical science is made heir to the discoveries of photo-electric science. I shall briefly restate the leading facts of this science.

. . . . .

On the living cell γ or X-rays produce remarkable effects. The study of these effects in plants dates back several years. Schobert, Errera, Molisch, Guilleminot, and others have contributed to it.[2] The rays may retard cell division, and more especially affect the germinating embryo. They may kill such cells. They may also in very feeble doses promote cell division. Gaskell has specially studied the effects of X-rays on the embryonic cells of the chick.[3] He found that up to a certain amount of exposure the embryo may make complete recovery from the injurious effects of the rays, but that there is a critical dosage beyond which recovery does not occur and development stops. The effects of ultra-violet light in setting up mitosis in certain cells of the eye are beaufully shown in experiments by E. K. Martin (Proc. Roy. Soc., B 85, July, 1912, p. 319). Certain ultra-violet rays—the Schumann rays—are said to be always very destructive in their action on living protoplasm, giving rise to cytolysis and death in the cases of spirogyra, amœba, and other unicellular organisms, in less than one minute. These wave-lengths, which are about half the length of visible rays in the violet, are rapidly absorbed even in air. It has been sug-

[1] Based on a paper read to the members of the Dublin Clinical Club on March 16, by Prof. J. Joly, F.R.S. Reprinted with abbreviations and some revision from the Scientific Proceedings of the Royal Dublin Society, vol. xiv., No. xxxvii.

[2] "Le Radium," vii., 1910, p. 247.

[3] Gaskell, Proc. Roy. Soc., Ser. B, vol. lxxxiii., February, 1911, p. 305.

gested that destructive organic effects are due to untimely oxidation.

The physician possesses in radiation a subtle means of attacking the mechanism of cell-growth, and one of unlimited power. It is a characteristic feature of true scientific advance that new powers, based on newly-discovered forces, are placed at our disposal. The possibility of physical interference with the atomic linkages of organic structure and its sustaining metabolic processes is a recent conception. The older practice recognised one way only of effecting such interference—by the intervention of chemical actions set up by drugs assimilated through the digestive system. Although we are to-day far from a knowledge giving complete control of radiative effects, I venture to think that these will ultimately be found to be more definable and manageable than medicinal treatment.

Let us consider, so far as we can, what we are doing when we insert into a tumour a needle filled with emanation.

Within the tube the radio-active transformations of the atom are attended by three forms of radiations.

(1) α rays, which are positively electrified helium atoms, and cannot pass the walls of the tube. With these, therefore, we have nothing to do.

(2) Also β rays, or electrons, are sent out. Some of these are so slow as also to be stopped by the thin glass and steel walls surrounding the radio-active substances. But these walls are thin enough, as used in the technique introduced by the Radium Institute of the Royal Dublin Society,[4] to permit a large proportion of them to escape. Their velocity varies over a wide range, some electrons moving at speeds nine-tenths that of light. Their velocities are such as to give, as already stated, both a line and a continuous "spectrum" when sorted out by a magnetic field.

These electrons are known to be the direct agents in effecting ionisation. The faster electrons probably penetrate a couple of centimetres in soft tissues, their energy dying out in the creation of ions and secondary γ rays. The latter are re-converted to β radiations, which again take up the work of ionisation. Thus the whole of their energy, or the greater part of it, is, probably, ultimately spent in the work of ionisation: in other words, on work which is capable of seriously modifying the chemical and molecular processes progressing in the medium.

(3) There emerge, also, from the tube the γ rays of Ra B and Ra C. The latter enormously predominate, most of the rays of Ra B being sufficiently soft to be absorbed in the walls of the tubes. These rays, as we have seen, move with certain definite quanta of energy, or in integrals of a certain quantum in each case: in short, in trains of rays. Wherever they traverse atoms they give rise to β rays. Some of these, taking up the whole energy of a wave-train, move with velocities similar to the most penetrating primary β rays given out by the parent radio-active atoms. This is the inner history of the events leading to the ionisation of the medium according to recent views.

The number of ions which these rays can generate in air has been computed.[5] In reckoning the number of ions two count for one, as each electron separated involves the formation of both a + and a − ion. The numbers given refer, therefore, to pairs of ions.

The quantities of the substances Ra B and Ra C used in the estimates are those which will be in equilibrium with one gram of elemental radium or with one curie of emanation. These substances alone concern the surgeon when he applies radio-active treatment by usage of the emanation. The rays are supposed to act for one second of time.

From β rays of	Ra B	... ...	0.325×10^{15}
,, β ,,	Ra C	... ...	0.64×10^{15}
,, γ ,,	Ra B	... ...	0.084×10^{15}
,, γ ,,	Ra C	... ...	1.134×10^{15}
	Total	... ...	2.183×10^{15}

Now it is of interest to estimate what these numbers would represent in the therapeutic use of these radiations in body-tissues, on the assumption that the energy is in a similar degree expended on ionisation—an assumption which may approximate to the facts, seeing that the mere state of aggregation—solid, liquid, or gaseous—should not much affect the results. I take the volume of an average cell as 125×10^{-9} cubic centimetres, which is the volume of a cube 1/500 of an inch on the edge.

I shall assume the surgeon inserts the radio-active needles containing the emanation one centimetre apart, and that he has only one millicurie in each needle, the radio-active length of the needle being one centimetre. I shall also assume, as a first approximation, that the radiations are completely absorbed within the boundaries of the tumour being treated.

The number of pairs of ions generated per second by one millicurie will be 2.18×10^{12}. And as the needles are one centimetre apart, we have this number generated per cubic centimetre. In a single cell the number is 272×10^3 pairs of ions.

In actual practice there may be about five millicuries in each needle. We have then, theoretically, more than 1.3 million pairs of ions generated per cell per second. The assumption that all the rays are absorbed in the tumour is not accurate, and again the numbers given apply to quite unscreened radiation only. The softer β and γ rays suffer absorption in the glass and steel envelopes. This loss applies chiefly to the rays from Ra B. In order to make a safe allowance for these sources of error, as well as for the loss of the most penetrating of the γ rays of Ra C which escape from the tumour, I take 50 per cent. of the calculated number of ions, that is, 136,000 pairs of ions per cell per millicurie per second; or, in the working conditions, 680,000 per cell per second. In exposures measured by hours the numbers rise to thousands of millions: in ten hours to twenty-four thousand millions of pairs of ions per cell.

These figures are instructive, whether they represent entirely effective and useful ionisation or not. Even if only a small fraction is usefully expended, they reveal the power of radio-therapeutic methods in controlling or initiating chemical changes within the cell.

The effects of this powerful ionisation on the cells of the body have been demonstrated repeatedly by microscopic examination. I would refer more especially to the fine series of photographs obtained by A. Clifford Morson on carcinoma and sarcoma before and after exposure to radiation.[6] After treatment for twenty-four hours with 90 mgrms. of radium the obliteration of structure is far advanced, or even, to all appearance, complete. In the case of healthy cells of the rat, Lazarus-Barlow has shown that considerable exposures may produce no more than temporary disturbance of growth, and that even while treatment is proceeding the cells may become again apparently normal.[7] The important point has frequently been brought out that the healthy cell behaves as a less sensitive system. This, of course, is at the basis of radio-active treatment. It is not improbable that a dosage which will

[4] Stevenson, *Brit. Med. Jour.*, July 4, 1914, and March 20, 1915.
[5] Moseley and Robinson, *Phil. Mag.*, vol. xxviii., September, 1914.
[6] Morson, "Archives of the Middlesex Hospital," xxxiii., p. 110.
[7] Lazarus-Barlow, *loc. cit.*, p. 34.

do no more than stimulate mitosis in a healthy cell will suffice to destroy the less stable cancer cell. The latter is, indeed, so unstable towards the ionising effects of the rays that a very small dose will arrest development, and even cause the destruction of the cell. A tube guaranteed to contain five milligrams of pure radium bromide was several times applied to cases of cancer in this city, the tube being screened with thin sheet-lead and applied externally. It was afterwards found that the tube contained but 0·8 mgrm. of radium element. This was, therefore, a very small dosage. All the results obtained were, however, beneficial. The whole subject is probably in its first stages of investigation in spite of the work which has been done.

Failing the guidance which investigation will assuredly one day give us, it is interesting, and, possibly, important to discuss the cell as a photo-sensitive molecular system, and in so far comparable with another photo-sensitive molecular system, the study of which is less difficult to pursue.[8]

Of all photo-sensitive systems with which we are acquainted the photographic film is at once the most accessible to observation and the best understood; although in this, no more than in any other case, is our knowledge complete, or our views always capable of actual demonstration. We know it to consist of halogenised molecules emulsified in an organic colloid, the relations of salt and colloid being probably complex, and such that they react one upon the other in responding to the photo-electric effect. Certain features in common with the cell will be recognised in this statement. It is, indeed, possible that we might apply it word for word as a general description of the activity of the cell as a photo-sensitive system.

The photograph is an effect of photo-electric activity. This activity, which operates during exposure, generates the latent image. The latent image is afterwards acted on by the developer, and the negative produced.

In this process we start with a halide of silver, loosely combined with the complex molecule of the gelatine, or in a state of solid solution, the instability of the silver halide being increased by its immersion in the gelatine according to principles which have been pointed out by Sir J. J. Thomson, in the case of ordinary solutions in water.[9] We end up with separated metallic silver. The process is, then, one of reduction on the whole. But it is effected in two stages. First, the photo-electric action; then the chemical action of the developer or reducing agent on the latent image.

The view that the process of formation of the latent image is founded in the expulsion of the electron under the photo-electric force is supported by many circumstances.[10] . . .

What may be described as a state of static ionisation is set up, the discharged electrons creating negative ions by attachment to the gelatine surrounding the silver-bromide-gelatine systems, and forming an electro-negative region which may be regarded chemically as comparable to an increase in negative ionic concentration.

The developer acting at this stage—*i.e.* when the latent image has been formed—finds the process of reduction facilitated by these conditions. For the developer is essentially a reducing agent, and the latent image represents a temporary release of the positive silver ion from attachment to the chlorine ion, the latter having lost its charge.

The latent image is, in short, one stage in the reduction of the complex silver bromide molecule. But it is a stage reached by physical means, and owes its stable character to the solid nature of the medium in which it is immersed. Nevertheless, it runs down in course of time and disappears; the negative electron gradually being attracted back to the central positive system, and re-combining with the chlorine whence it came. The process of destruction may be accelerated by over-exposure to light, X or γ rays. This is the phenomenon of reversal or solarisation. The probable explanation is that by continued exposure the electrostatic stress set up by electronic segregation accumulates to the point of rupture, and there is a hurried return of the electron to its starting point under the electric stress.

The latent image may also be induced by friction, pressure, or, generally, by mechanical irritation of the film. The action of the mechanical stimulus is probably to induce directly the separation of electrons, *i.e.* to promote the negative ionisation. A latent image so formed can be reversed by radiation.

The reversal of the latent image may, in some cases at least, be effected by the infra-red and the heat waves. This might have been anticipated from the theory given above, for we would expect a feeble displacement of the electrons by the long waves, under which effect they would re-combine.

We have now to consider the formation of the latent image by chemical means.

If the latent image is essentially the result of a partial reduction of the silver halide we should expect its creation by reducing agents. The developers and sensitisers, in point of fact, generally create the latent image, and act most effectively when alkaline, *e.g.* pyrogallol, gallic acid, tannin, aqueous solutions of nicotine, and—it is stated[11]—alkaline solutions of lactose and glucose. These substances, acting as developers, must, whatever stages may intervene, ultimately neutralise the charge upon the positive silver ion in the emulsion, setting it free as metallic silver. The effects are probably continuous with those of radiation in creating the latent image. Dilute solution of ammonium hydrate alone will give the latent image. Some substances act as sensitisers, or owe their special efficiency as developers to their active absorption of the halogen.

As opposed to the effects of the concentration of the negative hydroxyl ion in alkaline development, the action of the positive hydrogen ion upon the latent image is to inhibit its growth, or reverse it if already formed by light or otherwise. This result is made apparent by introducing a very weak solution of a mineral acid. The oxidation of the reduction product, or the re-halogenisation of the partially reduced silver, may be involved, according to the nature of the acid used. The feature common to all acid intervention is the increased concentration of the positive hydrogen ion.

The photo-sensitive molecular system of the film can exist in different states of sensitiveness, ranging from a highly sensitive to a relatively insensitive state. The behaviour of the "ripened" emulsion of the fast plate (*i.e.* of an emulsion which has been subjected to a process of prolonged heating) is similar in kind to that of the "unripened" emulsion of the slow plate, but in the former all the phenomena are relatively advanced. The latent image is sooner formed under a given exposure, and much more readily reversed. Chemical effects are correspondingly accelerated. The grain of the sensitive or ripened film is much coarser than that of the slow or unripened film.

We now turn to the living cell.

We find that radiation may, if carefully modulated,

8 Joly, Proc. Roy. Soc., Ser. B, vol. lxxxviii., 1914.
9 J. J. Thomson, *Phil. Mag.*, vol. xxxvi., 1893, p. 320.
10 Joly, Nature, vol. lxxii., July 27, 1905, p. 308.

11 Meldola, "Chemistry of Photography" (Macmillan, 1891), p. 190.

stimulate, and, if too intense, retard its growth, and ultimately destroy the molecular structure required for mitosis. In so far the effects on the growth of the cell—superficially, at least—resemble those on the formation of the latent image.

It is also found—and, as already stated, the whole efficacy of radio-active treatment turns upon this—that in the case of the pathological cell these phenomena appear all in advance of the like effect in the normal cell. There exist then states of the cell differing in sensitiveness towards radiation just as there exist differing states of the film.

The accelerated mitosis and growth of the pathological cell appear in some cases to be traceable to repeated mechanical stimuli. This is parallel with the formation of the latent image by similar stimuli.

Finally, the destruction of the pathological cell is said to be brought about by thermal radiation of a certain intensity. A method of treatment has even been founded on this. The parallel with the latent image also appears here.

There is, then, a very complete parallel between the effects of radiative and mechanical stimuli in both cases, the latent image and the cell. The formation of both may be promoted by radiation, and by the same radiation in excess may be finally destroyed. It seems permissible to ask if the same parallel does not extend to more definitely chemical effects. The point is important, not only on the score of the convenience and accessibility of the plate as a means of investigation, but because of certain conclusions which can be drawn from already known data, and which possibly possess a bearing on what is termed the cancer problem.

We may state the argument thus:—We find certain chemicals producing in the film what are to all appearance identical effects with those generated in it by radiation. And reasoning from the fact that radiation produces parallel results in the case of the cell and the film, we ask if those chemicals which affect the latent image in the direction of acceleration or retardation may not also in like manner affect the cell. The view that this question is legitimate is supported by some observational facts, as will presently appear.

But first it is necessary to look more closely at what may be really involved in comparing the formation of the latent image with the growth of the cell. If, at any stage of its metabolism, a partial (or complete) reducing action takes place in the cell in which the halogen and the colloid present take a part, the similarity between the two results may be more than a parallel. It may be based on actions chemically or physically identical, or practically so. There may, in fact, exist, as a stage in the life of the cell, relations between the negative halogen ion, a positive ion united with this, and the protoplasm, similar to that prevailing among the elements of the film. If such exist, the explanation of the resemblance in the response of the two systems towards different agents, physical and chemical, is at once forthcoming. We are not in this case involved in the statement that the growth of the cell and of the latent image are parallel actions beyond the inference that a certain molecular rearrangement necessary for the growth of the cell is similar in character to what is presented to our study in the formation of the latent image. In a sense the formation of the latent image is katabolic, that of the cell is anabolic. We are not, however, forcing a complete comparison between them, nor do the observational facts call upon us to do more than recognise *some* photo-sensitive molecular process involved in cell-growth similar to one involved in the formation of the latent image.

There seems to be no doubt that the growth of the cell is highly sensitive towards ionic concentration. Confirming and extending the results obtained by Loeb in 1898, and using similar methods, Moore, Roaf, and Whitley have found by direct observations on the embryonic cells of Echinus that even small increase in the concentration of the negative ion $(\overset{-}{HO})$ will accelerate growth.[12] But if the alkalinity be increased yet a little, pathological mitoses make their appearance, and at a slightly greater alkalinity the chemical actions necessary for the life and metabolism of the cell are inhibited. On the other hand, an increased concentration of the positive ion $(\overset{+}{H})$ from the first retards, and, if pushed further, inhibits, growth. The parallel with the action of alkaline sensitisers and acid retarders upon the film is obvious.

Observations showing an abnormal lowering of acidity in the digestive secretions of cancerous patients have been made by several investigators. Messrs. Moore, Roaf, and Whitley in 1905 found that the diminution of hydrochloric acid in the stomach was independent of the location of the disease.[13] Copeman and Hake, in 1908, published results which failed to confirm those of Moore.[14] The question as regards the secretion of HCl cannot be regarded as finally settled. But a lowering of acidity as a frequent feature in cases of malignant disease seems to be accepted as proved. With old age a similar phenomenon is observed, and with advancing years the liability to cancer increases.

These facts suggest that the antagonistic action of the acid and the alkali in the cell is parallel with the antagonistic action of restrainer and sensitiser upon the film. The latter may be illustrated by a simple experiment on the film. A latent image is formed on a dry plate, either by brief exposure to light or by application of a sensitiser. The application of a wash of very dilute HCl left on the plate for a couple of minutes will then obliterate the latent image, as will be found upon applying a developer. The effect is best obtained with highly dilute acid. Such a strength as is said to prevail normally in the secretion of the stomach—0·2 to 0·4 per cent.—works effectively.

The possibility that substances which act as sensitisers or restrainers on the film may act to promote or retard mitosis in the cell must be admitted from these results, some of which are obtained by direct experiment on the living cell.

The fact that cancer of tongue, lip, and throat, and generally of parts around the mouth, is chiefly confined to the male sex has before now been regarded as raising a suspicion as to the injurious effects of tobacco smoking.[15]

The effects of a solution of the volatile substances evolved from burnt tobacco, upon the film, support this inference. If tobacco smoke is bubbled through water, and a little of this water is poured on the photographic plate in the dark, and again washed off, a vigorous latent image will be obtained, as development will demonstrate.

Now C. and R. Hertwig and Galleotti[16] mention nicotine as one of a few substances which they found, by direct observation on animal cells, produced pathological mitosis and derangement of cell-division closely similar to those which are observed in cancer growth.

It is evident that we may find, in this indica-

[12] Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. lxxvii., October 1905.

[13] Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. lxxvii., May, 1905.

[14] Copeman and Hake, Proc. Roy. Soc., Ser. B, vol. lxxx., June, 1908.

[15] Statistics of cases treated in the Middlesex Hospital in 1913 show that the number of cases of the kind in the male and female sexes stand as 8.3 : 1. Archives, xxviii., p. 2.

[16] Referred to by Moore, Roaf, and Whitley, Proc. Roy. Soc., Ser. B, vol. xxvii., October, 1905.

tion of the film, support for our line of reasoning. The substances present in tobacco—probably the intensely alkaline substance nicotine in chief—set up in the cell those same electro-negative conditions which cause or assist it to promote the formation of the latent image, and in this way locally precipitate a state of mitotic instability which from other causes—to be presently discussed—may prevail as a tendency throughout the body cells of the patient. Local mechanical stimuli may contribute. It is, of course, not impossible that in many cases of the kind the effect is so far due to the local causes that but for these the cancer would not anywhere have invaded the body.

According to Dr. W. S. Bainbridge ("The Cancer Problem," p. 67; New York: The Macmillan Co.), "cancer of lip, tongue, cheek, and buccal mucous membrane is of relatively frequent occurrence in both sexes in India, in consequence of the chemical irritation produced by the chewing, or holding in the mouth, of a mixture of betel leaves, areca nut, tobacco, and slaked lime."

The seeds of *Areca catechu* are rich in tannin and also contain arecolin, an alkaloid closely related to nicotine, being, in common with it, a derivative of pyridine. Choline, a strong base answering the general reactions of alkaloids, is also present. The betel leaf is the leaf of *Piper betle,* and contains yet another alkaloid of the pyridine group—piperine (Haas and Hill, "Chemistry of Plant Products"; London: Longmans, Green and Co., 1913). It is worth noting that in this case both sexes suffer the increased liability to mouth cancer, and both sexes indulge in the habit.

An increase in the number of deaths from malignant disease within recent years is admitted by high authorities to be the only conclusion we can draw from the statistics, after every allowance for error has been made.[17] Modern advances in surgical and medical science undoubtedly enable life to be prolonged in many cases, or even cure to be effected where formerly speedy death alone must ensue. This ought to be a set-off against improved diagnosis as a source of error in the statistics. If this increase is a fact, we have to look around for the cause. It is, assuredly, not founded in anything of an evolutionary nature. I say this because if its origin be in the cell itself, a very profound change—profound because seated in the primary organic structure—must be supposed to have taken place within a few decades. Indeed, if the increase is what we judge it to be from the figures, it has taken place within a single generation, or at most two generations. This quite precludes evolutionary change acting through Mendelian factors. The view that some general body-change is involved appears to be supported by the fact that local causes will initiate the disease in some subjects and not in others. Consequently we must look to some article of diet or some custom of life which can reach and affect the stability of the cell. There are obvious difficulties in laying the blame for a change so deep-seated on a custom. Moreover, we look in vain for any custom at all likely to be responsible. When, however, we come to the possibilities of diet, we see much less difficulty.

In view of what has already been stated, it is legitimate to pursue the matter yet further, and to ask if within recent years we are not taking into our bodies more abundantly than formerly some substance or substances which might be held responsible for the increase of cancer. Many accustomed articles of diet may, doubtless, contribute in some degree towards abnormal cell mitosis and yet be quite harmless under the conditions of consumption. As already stated, it is known that alkaline solutions of lactose and glucose possess the parallel qualities required for affecting the photo-sensitive films. I have not obtained this action on the ordinary dry plate, nor got any latent image with ordinary sugar in alkaline solution. Milk, however, gives a faint effect, and this may be due to lactose. Sugar is an article of diet the consumption of which has increased in modern times, and the evidence for its sensitising activity—either directly or indirectly—should not be lost sight of as possibly concerned in the cancer problem; although it must be regarded as *a priori* improbable that a great natural food would act in this way.

A more suspicious substance is found in tannin. This substance enters, as all know, largely into the composition of teas of all varieties to the extent of, usually, 11 to 26 per cent.; and 60 to 80 per cent. of this is obtained in the normal extract. Tea, as an article of diet, has replaced all other beverages in the light meals of the day. This especially applies to the better-off classes. In former years this beverage was only taken at "tea-time." The cancer statistics when compared with the statistics for the consumption of tea in this country show features in common. Both curves rapidly rise for several decades preceding the last, and within recent years show a somewhat less rate of increase.[18]

As regards the consumption of tannin in other countries, it is to be remarked that this substance enters into coffee to the extent of about 22 per cent., and is present in red wines. Obviously without statistics both as to the consumption of tannin-containing beverages and of the prevalence of cancer we cannot discuss the geographical evidence. It is stated that in China cancer has long been a prevalent disease. In Australia tea is said to be largely consumed. The cancer death-rate is reported to be as large as in Great Britain, and to be increasing.

Tannin or gallotannic acid is itself a photographic sensitiser, and has long been known as such. It absorbs the halogens.[19] It is the parent substance of a complicated and only partially studied group of substances in which the reducing properties required for development and sensitisation seem to prevail. Thus gallic acid, a derivative which does not coagulate albumen, and is said to be absorbed in the body by administration of tannic acid, is a developer and sensitiser. Another derivative is the powerful developer pyrogallic acid, which along with gallic acid is stated by some writers to be excreted by the kidneys. As transported in the circulatory system these substances must, of course, acquire neutral or faintly alkaline characters. Other substances which possess the requisite reducing properties, and are constituents of the complex tannins, are pyrocatechol and hydroquinone.

Thein (or caffein) does not appear to exert more than a very feeble effect on the film, even when in a state of saturated solution, either neutral or distinctly alkaline. This substance is stated to be excreted unchanged.

If the increased prevalence of cancer is wholly or in part traceable to the increased consumption of tannin, we must regard the derivatives of this substance as predisposing the cells throughout the body to the incidence of the disease. The appearance of the disease at any particular point in the body is probably determined by local stimulus of cancerous mitosis. The view suggested is that a general instability or irrit-

[17] See "Encyclopædia Britannica," last ed., Art. *Cancer.* Statistics for cancer in England and Wales (1912) show the highest mortality till then recorded. (*Daily Mail Year Book,* 1915.) The more recently issued statistics for 1913 reveal a still higher death rate.

[18] Compare figures given for tea-consumption in Thorpe's "Dictionary of Applied Chemistry," art. *Tea,* with the Cancer Tables in Burns's "Vital Statistics Explained." (London: Constable, 1914.)

[19] Meldola, *loc. cit.*, p. 98.

ability is promoted throughout the body cells by this substance tannin; or rather, by the derivative or derivatives of it which are absorbed in the body; the effects being mainly due to the reducing properties. A state is at length reached after long and excessive absorption of the injurious substance in which local causes are competent to precipitate the pathological mitosis and cell proliferation. These causes are various. It may be a local chemical stimulus, as by the application of a powerful sensitiser such as nicotine, or possibly "nut-gall ointment." Other local causes, as has often been suggested, may be the increased mitotic activity prevailing in the organs of generation. Here there is already a local approximation to the conditions induced by increased electronegative ionisation. Dr. Lazarus-Barlow's results on the segregation of radium in cancerous tissues may indicate yet another local cause. Mechanical stimuli are probably responsible for the sweep cancer, etc.

The frequent recurrence of cancer after its local extirpation or destruction follows as a matter of course according to the present views. For, even apart from metastatic spread of the disease, the local cure is likely to be only temporary if the patient continues to absorb the sensitising agent into his system, or, possibly, has already permanently affected his tissues by its use. Where so much is involved, should not the physician consider the advisability of the denial to the patient of tannin-containing beverages?

The effect of tannin as an influence on mitosis is very probably responsible for the phenomenon of "vegetable cancers" or galls on trees or shrubs. Galls may contain up to 75 per cent. of tannin. These growths originate under the stimulus of irritation by some insect. Pfeffer, Sachs, and others have recognised that tannin in plants is abundant in places where growth is specially active; such as growing points, pathological growths, and places where the protoplasm is specially irritable.[20] We must remember that when we come to the cell there is not so much to differentiate the vegetable from the animal.

LIBRARY PROVISION AND POLICY.

THE Carnegie United Kingdom Trustees have published the parts which are not of a confidential character of a report on library policy prepared for them by Prof. W. G. S. Adams. Though the Trustees do not commit themselves to the policy or the recommendations of the report, they consider it will be of interest and value to those concerned in the development of public libraries in this country.

It seems that Mr. Carnegie has made 295 grants to rate-supported libraries, amounting to a total sum of 1,768,404*l*. Most of these grants extend over the period from 1897 to 1913, and vary from 400*l*. to 120,000*l*. The grants have been almost exclusively for library buildings, including in many cases furnishing, but not for endowment, maintenance, librarianship, or the purchase of books.

A table provided in the report shows that few among the libraries which have received these grants spend more than 150*l*. a year on books—a small sum if a library is to be kept moderately efficient, and that 120 libraries have an expenditure on books and binding of not more than 50*l*. per annum.

The chief criticism Prof. Adams offers concerns grants made to centres which have been unwilling or unable to support a library on the scale which Mr. Carnegie provided. It may be summed up in the word "overbuilding." Libraries have, in a number of cases, been provided, involving a scale of expenditure on upkeep which left no sufficient means for the main purpose and object of the library. Buildings in several instances costing 10,000*l*. or even larger sums have been erected, the upkeep of which absorbed the greater part of the income from the 1*d*. rate, leaving a mere pittance, and in some cases not even that, for the purchase of books. In certain instances, where there had previously been a library on smaller premises, the gift of the larger building has ultimately involved a reduction in the expenditure on books. In many cases there is not an adequate income to provide a librarian worthy of the building and competent to create the true library. The criticism thus reduces itself to the error of overbuilding. The suggestion is frequently made that libraries in small towns would have been more truly assisted by smaller buildings and an initial grant in aid of the purchase of books.

Among suggestions for future action made by Prof. Adams is the assistance of libraries of a specialised character. He urges the claims of special libraries to provide literature for the blind, and for doctors in rural districts. Referring to the latter, he says:—

"It has been brought to my attention by Mr. MacAlister, the secretary of the Royal Society of Medicine, with its most valuable medical library, that it would be a great benefit, especially to doctors in country districts or poorer town districts, to have available a circulating library providing them with the special literature which they may wish to consult, but which they cannot afford to purchase. It is evident at the present time, with the great development which is taking place in medical science, that it is not easy for the practitioner to keep himself in touch with the literature which is of service to him. Yet the value of a special library for this purpose would be great, and would react undoubtedly upon the well-being of the community. Technical and scientific literature is expensive, and I understand that it is with such an object in view that there has been established in the United States the Surgeon-General's Library at Washington, which circulates medical books and journals to practitioners throughout the United States."

[20] Haas and Hill, "Chemistry of Plant Products." (London: Longmans, Green, and Co., 1913.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A REUTER message from Cape Town on June 4 reports that Mr. Marais, late member of the Union Assembly for Stellenbosch, bequeathed 100,000*l*. for the establishment of a university there. Mr. Marais was a Hertzogite, and the request is regarded as a counterblast to the Wernher-Beit bequest of 500,000*l*. for the Central University of Grooteschuur, which the Hertzogites opposed.

MR. FRANK FINN, official guide to the Horniman Museum and Library, Forest Hill, S.E., attends at the museum on Saturday and Wednesday afternoons, when his services are at the disposal of visitors, and on Saturday mornings, when his attention is mainly given to teachers. No fee is charged. Applications for the guide's services for special parties should be made to the Curator of the Museum.

WE learn from *Science* that the Circuit Court of St. Louis has confirmed the will of the late James Campbell, who left his entire estate to St. Louis University School of Medicine, subject to a life tenure of his wife and daughter. His estate is valued at from 1,200,000*l*. to 2,000,000*l*. From the same source we find that the late Mr. Ward N. Hunt, of Needham, Mass., has made Dartmouth College residuary legatee for 4000*l*., to establish scholarship funds to be known as the Hunt scholarships.

THE authorities of the University College of Wales, Aberystwyth, at the request of several county education committees, have organised a series of short courses for teachers and others at the college during the month of August next. Classes in the following, among other, subjects have been arranged: geography and nature study, rural science, and hygiene and temperance. A special course in geographical survey, nature survey, and allied subjects will be held under the joint auspices of the Provisional Committee for the Development of Regional Survey and the Department of Geography in the Aberystwyth University College. Prof. H. J. Fleure will give a course of lectures on the geography of western civilisation, and Mr. W. E. Whitehouse courses on map-reading, and local climatic surveys. The course in rural science is intended primarily for teachers in rural schools, and will include lectures on agriculture and land surveying by Mr. A. E. Jones, on agricultural chemistry by Mr. J. J. Griffith, and on school horticulture by Mr. J. L. Pickard. All inquiries with regard to the summer school should be directed to the registrar at the college.

COMMEMORATION day at Livingstone College was celebrated on June 3. The former principal and founder of the college, Dr. C. F. Harford, who is at present an officer in the Royal Army Medical Corps, presided. The secretary of the London Missionary Society, in the course of an address, said the training given at the college enables men to look after their own health, and that is an important point. In the first ten years of the history of the London Missionary Society's mission in Central Africa, eleven of the missionaries died and six were invalided home, and with one exception were never able to return to their work. In the last twelve years there has not been a single death in the mission, nor a single case of a man being invalided home. The average term of service of the first ten men who were sent to Central Africa was well under three years; for the last ten men sent to Central Africa, already their average term of service is more than fourteen years, and their average age about forty. The men have learned what Livingstone College teaches, the care of their own health, hygienic conditions, the need for building their houses in a healthy position and not on the side of a lake because it is a beautiful spot, the need for trying to drain the land round their houses, to avoid mosquitoes, the need for taking care of their heads when they are out in the sun.

THE pamphlet entitled "Suggestions for the Teaching of Elementary Science, including Nature Study," just issued by the Board of Education (Circular 904, price 1*d*.), is intended to supersede earlier suggestions on the same subject. It is a clear and practical guide, which embodies the experience of the most enlightened teachers of elementary science, and particularly of nature study. The needs of both teachers and scholars are considered sympathetically, and no more gratifying recognition of the value of nature study has, so far as we know, ever been printed in this country. Experimental science is, of course, treated slightly in the earliest stages of school life, but the beginnings of all kinds of science are here discussed with knowledge and insight. Hints to those who are called upon to prepare lessons in nature study are much more abundant than in the earlier editions, and being both practical and engaging, may be expected to kindle enthusiasm for the work. Of the many distinct merits which we find in the suggestions before us, none is more salutary than the spirit in which they are conceived and expressed. The Board of Education does much to encourage those who, during the last five-and-twenty years, have striven to improve school methods in elementary science, and we warmly recommend its counsels, not only to teachers in public elementary schools, but to all who teach children. Had the suggestions been locked up in a big report, we should have quoted some of the more remarkable passages, but the whole document can be bought for a penny and read in an hour; to enthusiastic teachers the task will be a pleasant one.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, May 25.—Prof. E. W. MacBride, vice-president, in the chair.—S. **Hirst**: A minute blood-sucking mite belonging to the family Gamasidæ. The mite was found on Couper's snake in the Society's Gardens, and is described as a new species of the genus Ichoronyssus.—H. R. **Hogg**: The spiders of the family Salticidæ, collected in Dutch New Guinea by the British Ornithologists' Union and Wollaston expeditions. One new genus and eleven new species were described.—G. A. **Boulenger**: The snakes of Madagascar, Comoro, Mascarenes, and Seychelles. The fauna of these islands is remarkable for the absence of snakes dangerously poisonous to man, with the exception of two sea-snakes known from the western part of the Indian Ocean. The paper contained a complete list of the species known to inhabit these islands, with keys to the identification of the genera and species.—Dr. F. E. **Beddard**: *Toenia tauricollis* of Chapman and on the genus Chapmannia. Dr. P. **Chalmers Mitchell**: The anatomy of the Gruiform birds, *Aramus giganteus*, Bonap., and *Rhinochetus kagu*. It was shown that *A. giganteus* resembled *A. scolopaceus* very closely in the details of its muscular and bony anatomy, and that the genus Aramus, in these respects, was very close to the true cranes.

Physical Society, May 28.—Dr. A. Russell, vice-president, in the chair. Dr. H. S. **Allen**: Numerical relationships between electronic and atomic constants. Jeans has pointed out that *hc*, where *h* is Planck's constant and *c* is the velocity of light, has the same physical dimensions as the square of an electric charge. Lewis and Adams have suggested a relation between these quantities of the form

$$ch = \sqrt[3]{\frac{8\pi^5}{15}}(4\pi e)^2,$$

which may be written

$$\frac{2\pi e^2}{hc} = \frac{(15/\pi^2)^{\frac{1}{3}}}{(4\pi)^2} = q,$$

where q is $7{\cdot}28077 \times 10^{-3}$. The square of this numerical constant is $p = 5{\cdot}30096 \times 10^{-5}$. The charge e on an electron in E.S.U. is found to be, within 0·1 per cent., $9p \times 10^{-6}$. The ratio e/m of the charge to the mass is found to be $p \times 10^{22}$, with the same order of accuracy.—H. **Moore**: A method of calculating the absorption coefficients of homogeneous X-radiation. The action of X-radiation when passing through a gas is to liberate electrons from the gas. The number of electrons emitted by any atom in a beam of X-rays is proportional to the fourth-power of its atomic weight (or possibly its atomic number). Thus, equal numbers of atoms of different elements, when subjected to similar X-ray beams, will liberate amounts of electronic radiation proportional to the fourth powers of the atomic weights of the elements.

The absorption coefficients are proportional to the amounts of electronic radiation liberated, and, therefore, the absorptions of two elements, when equal numbers of atoms are present, will be proportional to the fourth powers of their atomic weights. The corpuscular radiation liberated in the vapour of an element if it could be obtained as a monatomic vapour at 76 cm. can be expressed as $1{\cdot}05 \times 10^5 \times (\text{atomic weight})^4$, taking the corpuscular radiation in air as unity. The absorption coefficient of such a vapour would, therefore, be this number of times the coefficient of absorption of air for the same type of X-radiation. The absorption of any element is proportional to the number of atoms present, and having calculated the absorption in a hypothetical vapour of this type, the absorption in the same element in any condition can be calculated by a simple density law. This is done for several elements (metals), and also, assuming an additive law, it has been calculated for some compounds. The agreement between the calculated values and the values obtained by different observers by direct experiment is close over a considerable range of radiations and absorbers.—Prof. O. W. **Richardson**: Two experiments illustrating novel properties of the electron currents from hot metals. The first demonstrates the cooling of a tungsten filament when an electron current is allowed to flow from its surface. This effect is analogous to the cooling due to latent heat when a liquid evaporates. An experimental lamp containing a fine filament of double tungsten is placed in one arm of a balanced Wheatstone bridge actuated by the current which heats the wire. When the electron current is allowed to flow, by completing a side circuit from an electrode inside the lamp to a point in the adjacent arm of the bridge, the galvanometer is deflected in a direction which corresponds to a reduction of the resistance (and temperature) of the hot filament. The second, in which a similar experimental lamp is used, demonstrates the flow of electron currents from a hot filament to a surrounding cylinder *against* various opposing P.D.'s up to about 1 volt. On account of the large currents from tungsten this effect can easily be shown on a galvanometer. The data can be used to find the velocities of the emitted electrons.—Prof. Ernest **Wilson**: Experiments on high permeability in iron. 1. When iron is subjected to a strong magnetic force it has the effect of reducing the permeability and increasing the hysteresis loss for given values of the magnetic induction. The effect can be largely removed by careful demagnetisation. It was thought that the earth's magnetic force might also have a polarising influence upon exposed iron, and an effort has been made to remove it by placing the specimen in a magnetic shield, and carefully demagnetising it. The permeability corresponding to small values of the magnetic induction is thereby considerably increased, and the hysteresis loss diminished. After a long period of rest in the shield the permeability has diminished, and on taking the specimen out of the shield it maintains its high value. 2. As regards higher forces, the specimen in this case is not shielded, but is subjected to a magnetising force during the time that it is allowed to cool through the temperature of recalescence. Either with an alternating or steady magnetic force a maximum value of the permeability of more than 10,000 is obtained. The material has been tested in the form of laminated squares or rings. With straight strips 8 cm. long, 1·5 cm. wide, and 0·053 cm. thick, built into the form of test pieces, the effect, though produced, could not be maintained, and the specimen with ordinary handling was reduced to the normal state.—T. R. **Merton**: An experiment showing the difference in width of the spectrum lines of neon and hydrogen. By "crossing" a Fabry and Perot étalon with a single prism spectroscope it is possible to discriminate between lines arising from different elements by the "visibility of the fringes." In the experiment a vacuum tube containing neon and hydrogen is examined in this way. The neon lines, being narrow, show sharp interference fringes, but for the hydrogen lines, which are broader, the limiting order at which interference can be seen is too low for fringes to be visible.

CAMBRIDGE.

Philosophical Society, May 10.—Prof. Newall, president, in the chair.—W. H. **Mills**: 1. The ketodilactone of benzophenone-2 : 4 : 2′ : 4′-tetracarboxylic acid. 2. The synthesis of 1 : 5-dibromo-3-*iso*propylpentane.—Dr. H. B. **Fantham** and Dr. Annie **Porter**: Further experimental researches on insect flagellates introduced into vertebrates. Herpetomoniasis can be induced in various warm- and cold-blooded vertebrates when the latter are inoculated or fed with herpetomonads occurring in the digestive tracts of various insects. The infection produced and the protozoal parasites found in the vertebrates resemble those of human and canine leishmaniases. An infection can also be induced in certain vertebrates when they are fed or inoculated with *Crithidia gerridis*, and both flagellate and non-flagellate stages occur therein, but no transition to a trypanosome was found. The following Flagellata have proved pathogenic to warm-blooded mammals when the latter have been fed, or inoculated subcutaneously or intraperitoneally with them: *Herpetomonas jaculum*, *H. stratiomyiae*, *H. pediculi*, and *Crithidia gerridis*. The hosts used were mice of various ages. That *H. ctenocephali* can infect dogs has already been shown by the authors. *Herpetomonas jaculum* and *Crithidia gerridis* have also been successfully fed or inoculated into cold-blooded hosts, namely, fishes (*Gasterosteus aculeatus*), frogs, toads, lizards (*Lacerta vivipara*), and grass snakes (*Tropidonotus natrix*). The authors believe that leishmaniases are arthropod-borne herpetomoniases, and that these maladies have been evolved from flagellates of invertebrates (especially herpetomonads of insects) which have been able to adapt themselves to life in vertebrates.—Sir G. **Greenhill**: Note on Dr. Searle's experiment on the harmonic motion of a rigid body.—W. A. D. **Rudge**: The electrification given to the air by a steam jet.

DUBLIN.

Royal Dublin Society, May 18.—Prof. Wm. Brown in the chair.—Prof. G. T. **Morgan** and G. E. **Scharff**: Certain preliminary experiments in the utilisation of peat tar. Specimens of peat tar obtained from the hydraulic scrubbers of a producer plant burning peat were distilled fractionally and subjected to a preliminary chemical examination. The distillates consisted in the main of neutral (non-acidic) oils, containing a notable proportion of unsaturated compounds. The presence of these unsaturated substances was manifested by the following properties: absorption of bromine or of atmospheric oxygen, decolorisation of permanganate and interaction with chromic or nitric acid. The fraction boiling at about 300° deposited, on cooling, crystals of wax melting at 35–42°; this material, when thoroughly drained from oil, was almost colourless. On washing the crude oils distilled from peat tar with dilute mineral acid a small proportion of ammonia was removed, together with pyridine and other organic bases. Extraction of the crude oils with aqueous alkali hydroxides and subsequent treatment of the alkaline liquor with dilute mineral acid led to the separation of a considerable proportion of acidic (phenolic) oil. This material was redistilled and divided into three main fractions. The first fraction (b. p. 100–200°), when emulsified with gum acacia and compared with carbolic acid in regard to its germicidal action on *Bacillus typhosus*, gave a carbolic acid coefficient of 7. The second fraction (b. p. 200–250°), under similar conditions, gave a carbolic acid coefficient of 17, whereas the third fraction (b. p. 250–360°) gave a coefficient of 31. The phenolic substances present in these fractions couple readily with *p*-nitrodiazonium salts, forming dark red azo-derivatives, and they also give distinctive colorations with a 4-triazo-3:5-dimethylpyrazole, a reagent which has been found to furnish characteristic colours with aromatic hydroxy-derivatives (Morgan and Reilly, *Trans. Chem. Soc.*, 1914, vol. cv., 442). These tests indicate that phenol oils' immediate homologues, the cresols, are concentrated in the fraction of lowest germicidal power, and that the active substances present in the two higher fractions are evidently more complex substituted compounds of phenolic character.—Prof. Wm. **Brown**: The subsidence of torsional oscillations and fatigue of nickel wires when they are subjected to the influence of alternating magnetic fields of frequencies up to 250 per second. The fatigue of nickel wire is increased as the rigidity is increased, and for a wire of given rigidity the maximum fatigue is not increased beyond a certain value when the frequency of the applied alternating magnetic field is increased nearly three times, but the fatigue takes place in a shorter period of time. In soft nickel wire there is a great difference in the subsidence of torsional oscillations due to the application of a longitudinal magnetic field and an equivalent alternating magnetic field, but the difference is small when alternating magnetic fields of frequencies 50 and 250 per second are applied.—Louis B. **Smyth**: On the faunal zones of the Rush-Skerries Carboniferous Section, Co. Dublin. This coast section was described and zoned by Matley and Vaughan in two papers (*Quart. Journ. Geol. Soc.*, 1906 and 1908). Owing to the scanty and poor material collected, certain parts of the exposure were only tentatively assigned to zones. Further collection has now cleared up their position as follows:—Rush slates (lower) Z_2, Rush slates (upper) and Rush conglomerate (lower) C_1, Rush conglomerate (upper) C_2, Carlyan and Kate limestones CS (a confirmation, in the main, of the former correlation). Lane limestone C_1, Lane conglomerate C_2, Holmpatrick limestone CS (all three previously placed in "? D of unknown position"). The Holmpatrick limestone is found to have a fauna closely resembling that of CS beds at Arnside, Westmorland.

PARIS.

Academy of Sciences, May 31.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The problem of the cooling of the earth's crust considered according to the method and ideas of Fourier.—Maurice **Hamy**: A reduction formula for prismatic spectra. Starting with the result of M. Salet that any wave-length λ can be expressed with a high degree of approximation by the formula $\lambda - \lambda_0 = h \tan k(l - l_0)$, in which λ_0, l_0, h, k are constants and l is the reading of the micrometer screw of the dividing engine used in measuring the photograph of the spectrum. A simplified expression for λ as a function of l is given, as precise as that of M. Salet, but much less laborious.—J. **Guillaume**: Observations of the sun made at the observatory of Lyons during the first quarter of 1915. Observations were made on fifty-eight days, and tables are given of the results, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Arnaud **Denjoy**: The descriptive theory of numbers derived from a continuous function.—M. **Glagolev**: The spectrum of the homogeneous secondary X-rays.—A. **Leduc**: Remarks on the proportion of oxygen in the atmosphere, according to MM. Guye and Germann. The author considers that 20·8 per cent. of oxygen found at Geneva is too low.—A. **Boutaric**: The velocity of reduction of potassium permanganate by oxalic acid. The reaction has been studied by a spectrophotometric method based on the absorption by the permanganate. Under the conditions of these experiments the logarithmic law does not hold true; the velocity of the reaction is not proportional to the quantity of permanganate existing in the solution.—Ph. **Flajolet**: Perturbations of the magnetic declination at Lyons (Saint Genis Laval) during the first quarter of 1915.—M. **Salet**: The law of dispersion of prismatic spectra. The measurement l of the distance of a line is related to the wave-length λ by the relation $\lambda = a \tan(bl + c) + d$. The differences between the calculated and measured values of l are of the same order as the experimental error (0·002 mm.).—J. **Wolff** and Mlle. Nadia **Rouchelmann**: Oxidation and reduction phenomena in the chromogens of plants.—Ch. J. **Gravier**: Phenomena of replacement after mutilation of corals from great submarine depths.

BOOKS RECEIVED.

With the Flowers and Trees in California. By C. F. Saunders. Pp. x+286. (London: Grant Richards, Ltd.) 7*s*. 6*d*. net.

Electricity for the Farm. By F. I. Anderson. Pp. xxiii+265. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 5*s*. 6*d*. net.

Mechanical Drawing, with Special Reference to the Needs of Mining Students. By J. Husband. Pp. 79. (London: E. Arnold.) 3*s*. net.

The Electric Dry Pile. By C. E. Benham. Pp. 37. (London P. Marshall and Co.) 1*s*. net.

Amœbiasis and the Dissenteries. By Dr. L. P. Phillips. Pp. xi+147. (London: H. K. Lewis.) 6*s*. 6*d*. net.

Volumetric Analysis. By A. J. Berry. Pp. 137. (Cambridge: At the University Press.) 6*s*. 6*d*. net.

Domestic Science. By C. W. Hale. Part I. Pp. xi+327. (Cambridge: At the University Press.) 3*s*. 6*d*. net.

The Ferns of South Africa: Containing Descriptions and Figures of the Ferns and Fern Allies of South Africa. By T. R. Sim. Second edition. Pp. ix+384 and plates. (Cambridge: At the University Press.) 25*s*. net.

Report for 1914 on the Lancashire Sea-Fisheries Laboratory at the University and the Sea-Fish Hatchery at Piel. Edited by Prof. W. A. Herdman. Pp. 240. (Liverpool: C. Tinling and Co., Ltd.)

Emma Darwin: a Century of Family Letters, 1792–1896. Edited by her daughter, Henrietta Litchfield. 2 vols. Vol. i., pp. xxxi+289; Vol. ii., pp. xxv+326. (London: John Murray.) 21*s*. net.

Canada. Department of Mines. Mines Branch. Report on the Non-metallic Minerals used in the Canadian Manufacturing Industries. by H. Fréchette. Pp. viii+197. Peat, Lignite, and Coal. By B. F. Haanel. Pp. xv+261. (Ottawa: Government Printing Bureau.)

Aeroplanes and Dirigibles of War. By F. A. Talbot. Pp. xi+283. (London: W. Heinemann.) 3*s*. 6*d*. net.

Red Books of the British Fire Prevention Committee. No. 189. Pp. 38. (London: British Fire Prevention Committee.) 3s. 6d.

Fifty-third Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan, and Twenty-seventh Annual Report of the Experiment Station, from July 1, 1913, to June 30, 1914. Pp. 559. (Lancing, Michigan: Wynkoop, Hallenbeck, Crawford Co.)

Library of Congress. Report of the Librarian of Congress, and Report of the Superintendent of the Library Building and Grounds, for the Fiscal Year ending June 30, 1914. Pp. 216. (Washington: Government Printing Office.)

Library of Congress. A List of Geographical Atlases in the Library of Congress. Compiled under the direction of P. L. Phillips. Vol. iii. Pp. cxxxvii+1030. (Washington: Government Printing Office.) 1.25 dollars.

Contributions from the Princeton University Observatory. No. iii.: A Study of the Orbits of Eclipsing Binaries. By H. Shapley. Pp. xiv+176. (Princeton, N.J.: Observatory.)

The Natural Theology of Evolution. By J. N. Sherman. Pp. xv+288. (London: G. Allen and Unwin, Ltd.) 10s. 6d. net.

Materials of Construction: their Manufacture, Properties, and Uses. By Prof. A. P. Mills. Pp. xxi+682. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 19s. net.

Constant-voltage Transmission. By H. B. Dwight. Pp. 115. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, JUNE 10.

ROYAL INSTITUTION, at 3.—Method of Presenting Character in Biography and Fiction: Wilfrid Ward.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The History of the Gradual Development of the Groundwork of Geographical Science: Sir Clements Markham.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

OPTICAL SOCIETY, at 8.—Note on the Achromatism of a pair of separated Lenses: T. B. Vinycomb.—Optical Accessories: W. Salt.—Trial Frame Manipulation:—John H. Sutcliffe.

FRIDAY, JUNE 11.

ROYAL INSTITUTION, at 9.—Music and Poetry: Dr. H. W. Davies.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Methods of Determining the Tilt of Photographic Plates: R. J. Pocock.—The Form of a Rotating Fluid Mass as Disturbed by a Satellite: H. Glauert.—Note on Errors of Measurement: H. C. Plummer.—The Rotation Period of Neptune: M. Hall.—*Probable Paper:* Determinations of Stellar Parallax made at the Royal Observatory, Greenwich: Communicated by the Astronomer Royal.

PHYSICAL SOCIETY, at 8.—The Coefficient of Expansion of Sodium: E. A. Griffiths and E. Griffiths.—(1) Notes on the Calculation of Thin Objectives: (2) On Tracing Rays through an Optical System: T. Smith.—The Accuracy of the Lens and Drop Method of Measuring Refractive Index: H. Redmayne Nettleton.

MONDAY, JUNE 14.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Expedition to the Karakoram and Eastern Turkestan: Dr. Filippo de Filippi.

TUESDAY, JUNE 15.

ROYAL STATISTICAL SOCIETY, at 5.—Annual General Meeting. At. 5.15.—The Multiplier and Capital Wealth: B. Mallet and H. C. Strutt.

MINERALOGICAL SOCIETY, at 5.30.—Detrital Andalusite in Cretaceous and Eocene Sands: G. M. Davies.—The Garnets and Streaky Rocks of the English Lake District: J. F. N. Green.—The Errors in the Angle of the Optic Axes Resulting from those of the Principal Refractive Indices Determined by Total Reflection: Dr. S. Kôzu.—The Meteoric Stones of Warbreccan, Queensland: Dr. G. T. Prior.—Autunite: A. F. Hallimond.

WEDNESDAY, JUNE 16.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Discontinuities in Meteorological Phenomena: Prof. H. H. Turner.—Battle Weather in Western Europe, 9 months August, 1914, to April, 1915: C. Harding.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Analyses of Agricultural Yield: II. The Sowing-date Experiment with Egyptian Cotton, 1913: W. L. Balls and F. S. Holton.—Soil Protozoa and Soil Bacteria: E. J. Russell.—The Enhanced Series of Lines in Spectra of the Alkaline Earths: Prof. W. M. Hicks.—On Certain Linear Differential Equations of Astronomical Interest: Prof. H. F. Baker.—The Partial Correlation-Ratio: Prof. Karl Pearson.—The Effect of Temperature on the Hissing of Water when flowing through a Constricted Tube: S. Skinner and F. Entwistle.—And other papers.

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THURSDAY, JUNE 17, 1915.

THE MOBILISATION OF SCIENCE

In a letter to the *Times* of June 11 Mr. H. G. Wells gives utterance to a plea which, unheeded in days of peace, may awaken a sympathetic response while the stress of war is upon the nation. In asking that faith in the man behind the gun shall not be made any longer an excuse for providing him with fewer or inferior weapons, he invites political leaders and the War Office to make the fullest use of scientific men and method in the conduct of the war. He asks for the appointment of an acting sub-Government of scientific and technically competent men which will organise our utmost resources of scientific knowledge and promote the employment of the most effective means of dealing with the enemy.

There are signs that things are moving in the direction which Mr. Wells indicates as the road along which triumph must be assured, and his letter should hasten the organisation of the scientific forces which will assist to this end. The publication of the total number of casualties during the last ten months ought to convince the nation that this war is one in which we cannot afford to give odds; and that all the force of scientific ingenuity and scientific organisation must be concentrated upon the military and naval operations. There are hundreds of men of science in the country whose energies and expert knowledge are not being effectively used. We should possess a scientific corps, with men investigating at the Front as well as at home, instead of one or two committees advising officials as to possible means of offence or defence. When a man of science of such distinguished eminence as Prof. J. A. Fleming can say, as he does in the *Times* of June 15, that after ten months of scientific warfare he has never been asked to co-operate in any experimental work or place any of his expert knowledge at the disposal of the forces of the Crown, though he is anxious to give such assistance, it is evident that the people in authority cannot understand the value of the scientific forces which it cheerfully neglects. Not a day passes but we are asked by men of science how they can devote their knowledge to national needs; and there is no ready answer. The organisation of the scientific intellect of the country is essential, yet almost nothing has yet been done towards its accomplishment.

It seems necessary, in considering how national needs may be met, to separate the invention of new methods of offence or defence from an increase in the supply of high explosive shell which has loomed so large in the newspapers. The novelty of the conditions and the unconventionality of the methods employed in this war carry the first problem outside the grooves in which naval and military engineers have hitherto worked; and the united efforts of civilians and Service men will be required for its solution. The necessity has arisen for surveying the whole scientific field to discover methods of destruction which we may use ourselves or from which our men look to us for protection. It is not enough that the Government should call in a scientific expert to advise in respect of what has occurred; they must be ready to meet it when it does occur. Moreover, such intelligent anticipation ought not to be the special property of one department, and departmental rivalry or indifference ought to be smothered at birth by the appointment of a National Committee with a free hand and ample funds for experimental work.

Such an arrangement is the more necessary in order to prevent the diffusion of effort over too wide a field. Some men are already engaged upon investigations of first-rate importance and yet unconnected either with industry or war; and others are doing work upon which the maintenance of trade depends. It should be possible to secure a sufficient number of men of adequate standing without encroaching in any way upon those we have mentioned. For the war will bring its aftermath of international competition, and we might as well lose as neglect to prepare for it. We plead, therefore, with Mr. Wells for a central organisation which shall direct into the most useful channels that mass of scientific knowledge and skill which is only waiting to serve the country's need.

But valuable as the work of such a committee might be, it would not obviate the desirability of using technically trained men to a far greater extent than is at present attempted, in increasing the output of the ordinary munitions of war. The problem before the new Minister is a dual one, and the two factors are labour and organisation. No man can do more than Mr. Lloyd George in persuading the workmen as a body to recognise the importance of unity and the danger which arises from industrial disputes; and every speech he delivers is both an inspiration and a warning. But it remains to be seen how far he will be able to secure that smoothness and efficiency of administration that is so completely the need of the hour.

The intention of the Minister has been pretty clearly expressed. Production is to be speeded up by using at first the most perfectly equipped shops, and by drawing labour and machines from those less fully qualified to undertake the work. It is to be hoped that an effort will be made to work three shifts in the twenty-four hours. There seems to be no reason why the students in the scientific and technological faculties of the universities and older boys in public schools should not be mobilised for this purpose. The greater number of jobs are carried out on automatic machines, the control of which can be learnt in a fortnight or less. The main object, however, is that the most efficient and economical methods of production must be adopted; the small shop, therefore, must stand out; and the individual must express his patriotism in co-operative effort.

Not a great deal of consolation is to be derived from the administration of local committees constituted by a careful balancing of interests and "municipalised" by the presence of the chief magistrate. If the local employers, managers, or foremen are giving the most effective service in their own works they will have little time for attending committees. A committee is as effective in affording opportunity for personal differences as it is for securing unanimity as to method and aim. The more such bodies are used in an advisory, and the less they are used in an executive capacity, the happier will be the result of their efforts. For getting things done one autocrat is worth twenty committees, provided that he has common sense and is neither a politician nor a lawyer who regulates action by precedent.

The work of organising our scientific and technical forces should not be put into the hands of men whose knowledge is limited to the etymological derivation of the names of things required—at least not in time of war, and it is imperative to consider whether the real resources of technically trained men have been tapped. A great many have entered the army and have been drafted into regiments where their specialised knowledge is of little use. Even then the fact that they can write has resulted in their being burdened with clerical work, which could as easily be done by women. But there are many men who for more or less adequate reasons are not in uniform and are only awaiting the call to industrial service. In comparison with previous wars the present conflict is not a war of men so much as a war of guns and ammunition, and if we are to hasten that end which we believe to be inevitable, we must concentrate every element of scientific knowledge and technical skill into its prosecution.

Scientific discovery, mechanical invention, and a highly technical organisation as employed by the Germans are only to be beaten by similar forces arrayed against them. It is not a time to say what ought to have been in the past, but what should be now and in the immediate future. We know that up to a certain point the scientific resources of the country have been drawn upon, but beyond the fact that one man is working at explosives, another at the Royal Aircraft Factory, and a third is testing for the Admiralty, we want to feel that these are only details of a wider scheme so perfect in its organisation that the full effect of our forty-five millions of people is brought to bear upon the enemy. Many people would sleep more peacefully if they knew that every technically trained man in the universities, university colleges, technical institutions, and in the Government Departments was not doing his "business as usual," but making it his special business to provide the nation with the scientific material and machinery by which alone can our forces achieve success in the present conflict.

MODERN ELECTRICAL THEORY.

The Electron Theory of Matter. By Prof. O. W. Richardson. Pp. vi+612. (Cambridge: At the University Press, 1914.) Price 18s. net.

THIS book is based on a series of lectures delivered by Prof. Richardson at the University of Princeton, and gives a general survey of the electron theory. The book starts with an account of the elementary principles of the theory of electricity and magnetism, and a discussion of phenomena which can be explained on the general Maxwell theory. From this we are gradually led to the discussion of such phenomena as dispersion and selective absorption, which have first found satisfactory explanations on the electron theory. Next follows a closer account of the theory of the mechanics of electrons, containing detailed considerations of the problems of electromagnetic mass, the radiation from an accelerated electron, and the properties of moving systems. This part ends with a brief account of the principles of the theory of relativity. After this we return again to the consideration of the general properties of matter, and the results deduced in the preceding chapters are employed in a discussion of the bearing of the electron theory on the problems of temperature radiation, magnetism, and the theory of metallic conduction. Finally, after an account of the theories of spectroscopic phenomena and the phenomena of radio-activity and X-rays, we are led into a discussion of the theories of the constitution of the atom.

It will be seen that the book covers a very extensive field. To give an adequate representation of the entire electron theory is naturally a task of the greatest difficulty, but the author appears to have done this in an admirable manner. Of necessity the treatment is at many points very restricted, but almost all points of general interest are considered. If any problem is treated more fully than others it is the theory of metallic conduction, as might naturally be expected from the author's own work. The exposition is throughout very clear and concise, and Prof. Richardson possesses a great gift of making even complicated arguments very easy for the reader to follow. A close connection with the latest experimental progress is everywhere maintained, and problems which involve hitherto unsolved difficulties are treated in a manner very far from being dogmatic.

In reading Prof. Richardson's book one gets ample opportunity to think about the present state of theoretical physics. The collection of the numerous brilliant achievements of the electromagnetic theory and the electron theory fills one with the greatest admiration. Still, the difficulties, first discovered with relation to the problem of temperature radiation and later in other problems, seem to be so great and of such a fundamental character that the theory will need very great alterations. Even if a way is indicated by Planck's theory no satisfactory solution of the difficulties has yet been found. In text-books only a few years old one finds great enthusiasm over what was called the future programme of the electromagnetic theory. It was believed that this theory constituted a final accomplishment of ordinary mechanics, and there appeared to be no limit to the application of the general principles of the theory. This attitude has changed most decisively. The impression obtained by reading the present book, however, is anything but merely disillusioning. Scarcely at any time has our knowledge increased so very rapidly as of late years, and, above all, we now possess much more powerful methods of experimental attack than were dreamed of a short time ago. Especially investigation of the radiation from radio-active bodies has proved most efficient in disclosing the internal structure of the atoms. If at present we may speak of a programme for the future development, it would, perhaps, be to examine the constitution of the special atomic systems actually existing, and then, by means of the directly observable properties of matter, possibly to deduce the general principles. If so, the evolution would be exactly the reverse of that anticipated.

In the present unsettled state, Prof. Richardson's book, which gives a balanced and masterly survey of a wide range of knowledge, will no doubt be especially welcome. It can be most heartily recommended, not only to students who seek an introduction to the electron theory, but to all interested in the modern development of physics.

N. B.

HORTICULTURE AND BOTANY.

(1) *The Standard Cyclopedia of Horticulture.* Vol. ii., C–E. By L. H. Bailey. Pp. 603–1200. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 25*s.* net.

(2) *Forage Plants and their Culture.* By C. V. Piper. Pp. xx+618. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 7*s.* 6*d.* net.

(3) *American Science Series. Essentials of College Botany.* By Prof. C. E. Bessey and Prof. E. A. Bessey. Pp. xiv+409. (New York: Henry Holt and Co., n.d.) Price 1.50 dollars.

(4) *The Story of Plant Life in the British Isles: Types of the Natural Orders.* Vol. ii. By A. R. Horwood. Pp. xiv+358. Vol. iii. Pp. xvi+514. (London: J. and A. Churchill, 1914.) Price 6*s.* 6*d.* net each.

(1) THE second volume of Bailey's "Cyclopedia of Horticulture" contains information on every subject pertaining to horticulture from "Cabbages" to "Extension Teaching in Horticulture," and is of a remarkably comprehensive character.

Every plant of interest the name of which lies between these two extremes is referred to; the derivation of the name is given, descriptive particulars of the plant, its geographical distribution, and notes on its method of cultivation go to make up each successive article. The book, though written primarily for the American horticulturist, contains much valuable information for extra-American countries. Certain articles, as that on the chestnut, remind one of the American origin of the work, as we are fortunate in being free from the dreaded chestnut fungus *Diaporthe parasitica,* which has caused such havoc in the United States. Diseases and insect pests receive extensive notice, and some forty double-column pages are taken up with descriptions of the various pests and the means of combating them. As with other articles, the text figures of fungi and insects are numerous and on the whole well-executed.

The genus Crataegus, which reaches so conspicuous a development in the States, has been carefully worked up by Prof. Sargent, and some nine hundred species are now recognised, to the confusion of European botanists and gardeners. In the encyclopædia the account of the genus occupies nearly eleven pages from the pen of Mr. Rehder, and the key to the fifty species which he mentions lends considerable value to the article. Eucalyptus again, another enormous genus but this time of introduced plants, occupies twelve pages, and there is a large illustration of a very fine specimen of *E. viminalis* growing in California. The key, which refers to as many as seventy-six species, is followed by short, useful descriptions with a few text-figures interspersed. Other large genera which fall within the compass of this volume are Cereus, Dendrobium, Echinocactus, Echinocereus, and Euphorbia, all of which receive very careful treatment.

There are a certain number of full-page illustrations, either in colour or in the form of photographic reproductions, which are well executed; among the latter that of cranberry-picking in a New Jersey bog makes a delightful picture; the coloured plates might have been dispensed with as they are of no particular interest. It is difficult to find any plant of importance or value which has been omitted. Owing to the large amount of material included, the volume is unduly bulky, and like other American publications suffers from its weight.

(2) "Forage Plants and their Culture" comes from the master-hand of the agrostologist in charge of forage-plant investigations of the United States Department of Agriculture, and is a valuable and well-illustrated agricultural handbook.

The introduction deals with forage crops generally, and in connection with the legumes an account of root nodules and nitrification is given. The chapters which follow treat of the preservation of forage and choice of crops, in which the results of feeding experiments, chemical analyses, the chemical composition as affected by the state of maturity of the crop, and other particulars are given.

The chapter on "Seeds and Seeding" is illustrated by useful plates showing the noxious weed seeds found among farm seeds. "Meadows and Pastures" and statistics of forage crops occupy the two next chapters. These are followed by detailed accounts of various crops, such as timothy, blue grasses, meadow grasses, the bromes, the sorghums, millets, and other grasses which figure prominently among the valuable forage plants of the United States. Among the legumes, alfalfa or lucerne occupies the first place, and the various clovers, peas, and vetches, soy beans, and other sub-tropical leguminous plants are discussed in some detail.

Root crops also come in for their share of attention. The book is written for the agriculturists of the United States, but the information it contains should prove of value to agricultural workers in South Africa, Australia, parts of northern India, and British East Africa, where many of the forage plants mentioned in the book can be successfully grown.

(3) A text-book which is said to contain only the essentials of the subject and written for "college teachers" may well be an uninteresting production, and that by Profs. C. E. and E. A. Bessey cannot be considered inspiring. It is to be hoped that the teachers who will use the book have already had their interest in botany roused and their enthusiasm for the subject fired by other teachers before taking up "the essentials" as a course of study. Not even the illustrations lend a helping hand, as they are singularly poor, and those of nuclear division are almost childish.

Though largely a very elementary treatise, the chapter on the chemistry of plants, with its masses of formulæ, is a formidable affair, and is too condensed to be of much practical value. The latter part of the book consists of a rapid classificatory survey of the vegetable kingdom with poor little figures. The book should not meet with much popularity on this side of the Atlantic.

(4) Mr. Horwood's second volume follows similar lines to the first one previously reviewed in Nature. The introduction gives a rapid review of general botanical information which is not always sound; the statement on p. 8, for instance, that if the nucleus is damaged the plant dies, would suggest to the uninitiated that a plant possesses only a single nucleus. Other sweeping assertions, such as "the endodermis . . . is graviperceptional," that parasitic plants possess root-hairs, and that "the protection of the stomata from being clogged is ensured by the provision of hairs and their occurrence on the under-side of the leaf," may be received with caution by those who have a wider knowledge of botanical facts.

Mr. Horwood, after mentioning that "very little free nitrogen is obtained from the air by plants," proceeds to remark on the temperatures favourable to plant growth, and apparently without having made his calculations from Centigrade to Fahrenheit, states that the "most suitable temperature for plant growth is about 28° C., though plants can grow below this," and further, "above a temperature of 56° C. plants usually die." This latter statement corresponds fully with our own experience. For the rest, the book treats in detail of the Thalamifloræ, Calycifloræ, and certain Gamopetalæ; descriptions of the plants and their natural orders are given, and there are numerous illustrations reproduced from photographs.

The author states that "the facts of botany, like those of zoology . . . are capable of reduction to orderly arrangement," and it is to be regretted that he has not found himself able to follow out his opening text in the ordering of his material.

The third volume recently issued completes the work. There are 95 pages of introduction dealing with germination, plant formations, and many other unrelated subjects. These are followed by three chapters devoted to the Corollifloral and Apetalous Dicotyledons, and the Monocotyledons. There are numerous photographic illustrations.

MANUALS OF PHYSICS.

(1) *Practical Heat, Light, and Sound.* By T. Picton. Pp. xv+151. (London: G. Bell and Sons, Ltd., 1915.) Price 1s. 6d.

(2) *Notes on Practical Physics for Junior Students.* By Prof. C. G. Barkla and Dr. G. A. Carse. (London: Gurney and Jackson, 1915.) Price 3s. 6d. net.

(3) *A Text-book of General Physics for College Students.* By Dr. J. A. Culler. (Philadelphia and London: J. B. Lippincott Co., 1914.) Price 7s. 6d. net.

(4) *Manuale di Fisica.* Vol. ii., Acustica, Termologia, Ottica. By Prof. B. Dessau. (Milan: Società Editrice Libraria, 1915.) Price 15 liras.

(1) SMALL school text-books frequently receive but scant attention from reviewers, but, when it is remembered that it is exactly in the earliest stages of a subject that students should be led to acquire those correct habits of thought and outlook without which real advance is impossible, we are not altogether persuaded that this attitude can be justified. It was with this in mind that Mr. Picton's book for the middle forms of schools was examined. An experimental exercise should have for its objects, first, the elucidation of physical principles, and secondly, should show how to conduct the measurements so as to obtain the best numerical result with the means at the disposal of the class. Most teachers will agree that the second of these is more easily secured than the first. As the preface puts it:—"A pupil may carry out conscientiously the written instructions, obtain a 'good result,' write a neat account, and yet have very indistinct ideas (and often no ideas at all) of the principles underlying the experiment." To overcome this mental inertia several questions are associated with each exercise, which must be answered before the student is allowed to proceed to the next experiment. The instructions are brief but sufficient, and can be thoroughly recommended for class-work. It may especially be noted that in the optical experiments a method is used which makes visible the paths of the rays—a considerable gain at this stage. The sections on concave lenses need revision, as the methods given are not the best available; also it would be a great advantage in future work if some use were made of books of tables, especially of reciprocals in lens experiments.

(2) Prof. Barkla and Dr. Carse's book is apparently a collection of some of the instructions used in the authors' laboratory at Edinburgh University. For the students there it will doubtless supply all that is required in the elementary classes, but beyond this it is not clear that it will fill any gap in the existing literature. As the directions are not written with reference to special forms of apparatus, they are available for the senior forms of schools. The first chapter on "Treatment of Observations and Determination of Error" is the best elementary discussion of the subject that we have seen.

(3) A comparison of English and American text-books of physics for colleges reveals a series of interesting differences. Taking them in order:—(1) American authors usually reduce the mathematical portions to a minimum; a rather unexpected feature if it be true that instruction in the States is so much more systematic than here, for in that case the usual excuse—that the student's mathematical knowledge is behind his physical requirements—should not be allowable. (2) More emphasis is placed on technical applications; a great advantage if the corresponding theory is developed. (3) There is a determination to be up to date as regards modern theories.

It is this last feature that is most strikingly in evidence in Dr. Culler's text-book. The author has set out to produce "a logical development of the live topics which, it seems, should be included in a text-book for college students," and, on the logical side, has not been altogether successful. To give two illustrations:—He desires to explain all the elementary electrical phenomena in terms of electrons, and finds it necessary to start the first paragraph with "What electricity is," followed on p. 3 with "Evidence for the electron theory," including a description of Thomson's experiments on kathode rays. Similarly, in the first page on magnetism we find ourselves immersed again in electrons. In each case terms have to be used which, at that stage, are incapable of definition, and a number of statements are made which the reader must take on faith. In several instances the treatment is too sketchy to be of any practical value; thus two pages are allotted to photometry, half a page to thick lenses (in spite of their technical importance), five pages to radioactivity, and twenty-three to sound. Nevertheless, if these blemishes are allowed for, it may be granted that the book is clearly and interestingly written, well got up, and likely to excite and retain the interest of the reader; but to take full advantage of its good qualities the student must not come to it as a beginner.

(4) Prof. Dessau's book, the second volume of a large text-book of physics, is admirable in its elegance, clearness, and choice of matter. The chapters on thick lenses and optical instruments may especially be mentioned as models of conciseness and lucidity. (Why is it that modern methods of determining refractive indices receive no mention in English books on physics other than those on physical chemistry?) But surely a book of 600 pp. should have an index!

EVOLUTIONARY MEDICINE.

(1) *Evolution and Disease.* By Dr. J. T. C. Nash. Pp. viii+73. (Bristol: John Wright and Sons, Ltd.; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1915.) Price 3*s*. 6*d*. net.

(2) *The Vicious Circles of Neurasthenia and their Treatment.* By Dr. J. B. Hurry. Pp. xv+90. (London: J. and A. Churchill, 1915.) Price 3*s*. 6*d*. net.

(1) In this work Dr. Nash first traces the history of certain epidemic diseases, in particular the Black Death, during the Middle Ages in Great Britain. An interesting chapter deals with the medieval psychopathic epidemics, such as the dancing mania. Much of this has necessarily appeared elsewhere, but it is none the less convenient to have the scattered literature of the subject thus briefly epitomised. The reader will probably turn with most interest to the chapters dealing with evolution and disease—in particular with the evolution and mutations of disease germs. As regards diphtheria, for example, the author states that diphtheroid organisms in throat swabs are uncommon except in cases of definite sore throat or in "contacts" with diphtheria or sore throat, that genuine cases of diphtheria with typical diphtheria bacilli often show later only diphtheroid bacilli in the throat swabs, and that some streptococci, some torulæ, the Klebs-Löffler bacillus, Hofmann's bacillus, and certain other diphtheroid bacilli, have a common ancestral origin, and concludes that the fact that bacteria and protozoa can be profoundly affected by environment is abundantly established, and evolution in relation to the germ cannot be gainsaid.

A topical interest is introduced in the final chapter on war as a factor in the evolution of epidemics.

(2) Dr. Hurry describes with considerable skill the vicious circles associated with that protean disorder known as neurasthenia. As an instance of a "vicious circle," that in connection with the heart may be quoted:—

"The sequence of events is somewhat as follows: The fear of organic heart disease leads to auto-suggested sensations in the cardiac region, followed by disturbance of the cardiac action, such as rapid heart, occasional extra beats with palpitation, and an intermittent pulse. The associated sensations then arouse distress and terror, which in their turn further disturb the cardiac action. Such attacks are especially common at night, and may be caused by nightmare, and the operation of this Circle may reduce the neurasthenic person to a condition of utter misery. Even fatal syncope may result."

It will thus be seen that the neurasthenic condition becomes evolved, as it were, given some factor which serves to start it and set in train the "vicious circle."

As regards treatment, while the principles are, it is true, indicated, the physician who desires real guidance will find little to help him, and we think that this part of the book might be usefully extended.

R. T. H.

OUR BOOKSHELF.

Heating and Ventilating Buildings. By Prof. R. C. Carpenter. Pp xiv+598. Sixth Edition. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 15*s*. net.

During the twenty years since this book was first published there have been many changes in methods of heating and ventilation. The present edition has been enlarged considerably by the addition of matter necessary to make it an up-to-date treatise on the subject. The author, who is well known as the professor of experimental engineering at the Cornell University, has dealt with the principles in a scientific manner, and has placed the various practical rules as far as possible on a rational foundation, at the same time avoiding the use of complicated mathematics. The earlier chapters are taken up with the properties of heat, the flow of water, steam and air, and the boilers and fittings required for steam and hot-water heaters. The remainder of the book contains thoroughly well illustrated descriptions of modern heating systems and includes gravity steam-heating, pump return steam-heating, hot-water and hot-air systems. There are also sections dealing with mechanical ventilators, heating with electricity, temperature regulators and air conditioning. The sections dealing with the amount of heat required for warming and with the heat given off from radiating surfaces are of special interest. It must, of course, be understood that the efficient warming of a large building is a matter that is not susceptible of absolute mathematical calculation, and a great deal of the measure of success attained lies in the manner in which the warming and ventilating appliances are handled by those in charge. The volume before us has proved in the past to be a useful guide to architects and others responsible for providing the arrangements, and with the information which it now contains will no doubt prove equally useful in the future.

Structural Steel Drafting and Elementary Design. By C. D. Conklin, Jr. Pp. vii + 154. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 10*s.* 6*d.* net.

THE author's object in compiling this book has been to provide a treatise dealing adequately with the preparation of shop detail drawings of structural steel work. Such a book is required no less in Great Britain than in the United States. In both countries there are several very good books dealing with the design of structural steel work. Some of these contain excellent expositions of the more theoretical work, but they do not meet the requirements of the practical draughtsman, and speaking generally, leave the reader with a very small knowledge of structural details. The book before us gives a clear and minute description of the methods adopted in some leading American drawing offices, and includes designs of riveted connections, beams and columns, steel roofs, a deck plate girder railway bridge, a through girder bridge, etc. Fully-dimensioned working drawings are given as well as the simpler calculations required in the design. The book is thus suitable for use in technical colleges, and provides a fairly complete course in structural drawing office practice. With a few minor modifications, which the teacher can easily supply, the book can be brought into line with British practice and nomenclature, and ought to be of service to students of structural steel work in this country.

Calculus Made Easy. By F. R. S. Second Edition. Pp. x + 265. (London: Macmillan and Co., Ltd., 1914.) Price 2*s.* net.

THE author of this book has added many worked examples and exercises to those in his first edition; otherwise the book is but little altered and we have not much to add to the remarks we made five years ago. The motto is, "What one fool can do, another can." Perhaps there may still be too many encouraging remarks of a jokesome nature and too many expressions of disdain for the stupidity of the usual methods of teaching, but the title of the book is justified. The author does show that the most fundamental operations of the calculus are easy to understand and may be performed by beginners with success, that is, without vague notions of being wrong. J. P.

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.*]

Surface Tension and Ferment Action.

MESSRS. BEARD AND CRAMER, in a paper under the above title published in the Proceedings of the Royal Society issued on June 1, describe experiments made with invertase with the object of determining "whether the action of a ferment on a substrate is affected by surface tension." They answer this question in the affirmative and draw far-reaching conclusions.

The method they use, however, is open to very serious criticism; we think that there is little doubt that the phenomena they describe are due entirely to the effect of alkali and not to change of surface tension. They have compared the activity of invertase towards cane-sugar in tubes filled either with glass wool or with capillary glass tubes or with glass beads with that of a control in an ordinary test-tube. Retardation of action was observed in all such cases.

All who have experience in working with saccharoclastic enzymes are well aware how extraordinarily sensitive these are to the influence of the minutest trace of alkali. This applies to the enzyme invertase in particular. In a paper published in the Proceedings of the Royal Society so far back as 1907 (Series "B," p. 362) we pointed out that unless hard glass vessels were used, it was impossible to obtain consistent results; in fact, it is not only necessary to carry out the action in hard glass vessels but it is essential also to use storage bottles and measuring pipettes of similar hard glass: even then the results are apt to be irregular.

The work done by Sörensen in co-ordinating enzyme activity with the degree of alkalinity or acidity of the medium is too well known to need description; his experience with invertase shows clearly how much the activity of the enzyme is influenced by the minutest trace of alkali. We look in vain in Messrs. Beard and Cramer's paper for any reference to the possible influence of alkali derived from the soft glass they used as a cause of retardation; it would appear that they have entirely overlooked this factor. So long as no definite evidence is brought forward to show that the retardation change they observed is not due to the action of alkali, it is unnecessary to attribute it to the influence of surface tension.

E. F. ARMSTRONG.
H. E. ARMSTRONG.

Training for Scientific Research.

IN connection with our position in regard to chemical industry, the present seems to be a suitable time for a careful discussion of what is doubtless not a new suggestion. It is a sufficiently obvious fact that the German chemical trades—especially those that most require highly-trained chemists—prosper in very much greater measure than our own, and, by general consent, the reason for this appears to be that the Germans appreciate the value of research more than we do. How then is a better appreciation of research to be fostered in this country? Various proposals to this end are being made; closer relationship between technical and theoretical chemistry, whatever that may mean; the establishment of an industrial council; the founding of scholarships, etc., all, doubtless, good things in their way, things, however, which have been tried already to some extent, but unfortunately without sufficient success to justify an expectation of their being able completely to accomplish the desired change.

In considering this question we ought, it appears to me, to search for some distinct difference between our educational practice and that of Germany, some difference great enough to be likely to have an important effect. Such is indeed easy to find, for there exists a difference so great that it might quite readily lead to very important results, and one which, probably because of its obviousness, is generally ignored. This far-reaching difference is simply that in Germany research work is absolutely indispensable for the *ordinary* degree (by "ordinary" I mean that ordinarily taken by students), and it is at least a very reasonable contention that the moment research work becomes essential for our ordinary degree (B.Sc.), with, naturally, any necessary lengthening of the course, so soon shall we have taken the step which will, not to-morrow, but in ten or fifteen or twenty years' time, perhaps place us on something like an equality with Germany in respect to the point at issue.

Two most important results might be expected to follow the introduction of compulsory research into the B.Sc. degree : (1) There would be provided throughout the country a considerable body of young chemists with some experience, say one year, at least, of research work. There is such a thing as a general method in research, and after even only one year's training in it the young chemist would be able to attack, with very much greater confidence than at present, many of the problems which arise in industrial practice, for in research work, emphatically, it is the first step that counts for most, and this first step being a thing that can be taught, it is the duty of the universities to teach it. (2) Sons of manufacturers who go to the university and take a science degree would of necessity carry out some original investigation, and from this particular class—composed of men who, for the most part, are possessed of some means and leisure—there would be likely to emerge a number of really capable chemists, who might indulge in the higher degree of D.Sc., men likely to carry their chemistry intelligently into their businesses. But even in those least interested there would necessarily be acquired some idea of what research means, some notion of how it might be applied to their own particular requirements, and it is probable that in a comparatively short time, say twenty years, the lack of appreciation of research work which is now attributed to the manufacturer would have wholly or largely disappeared.

In fact, the introduction of research into the ordinary degree would be likely to act in several ways. First upon the student, secondly upon the manufacturer, and thirdly upon theoretical chemistry by the achievement of the excellent educational principle, that the science would be the richer in some fact or in some theory for every graduate who had devoted himself to it. Fourthly, it would react upon the teachers.

Although this is, essentially, an exceedingly simple reform, there would doubtless be great difficulties in carrying it out; it would probably be urged that M.Sc. degrees have been instituted with this especial object, but that would be to misunderstand the present suggestion, the essence of which is that there shall be no degree at all, or anything resembling a degree, which does not require research work. At the present time, however, when traditional prejudices of all sorts are going by the board, it would probably be easy for the teachers to bring sufficient pressure to bear upon Parliament, or conversely, for Parliament or a resolute Government to bring sufficient pressure to bear on the teachers, to secure the immediate accomplishment of this desirable improvement.

It must, however, be sorrowfully admitted that such a change is not likely to make any particular financial difference to the young chemist, but in all probability it would give him a better opportunity for advancement once he had established himself in a technical post, and there is little doubt that the advantage to the country would be very great.

T. S. Patterson.

University of Glasgow (Organic Chemistry Department), June 8.

Galileo and the Principle of Similitude.

When I said in Nature (April 22) that Herbert Spencer was the first to apply the principle of similitude to dynamical problems in biology, I spoke in haste. I might have remembered that Borelli had shown, by help of this principle, that a man would never be able to fly by his own muscular power, and why (for instance) small animals are more active and leap higher than big ones. But I was quite ignorant of the fact that Galileo had treated the whole subject on the broadest lines and with the utmost clearness. His discussion will be found in the "Dialogues concerning Two New Sciences," admirably translated by Prof. Henry Crew and Alfonso de Salvio (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914). So numerous and interesting are the subjects dealt with in this wonderful book that the writer of a long and laudatory notice in Nature (December 24, 1914) had not time or space to mention that the principle of similitude and the subject of animal mechanics are alluded to therein. The following extract (*op. cit.*, p. 130) is but a small part of what Galileo has to say upon the principle of similitude :—

"*Salviati*: 'From what has already been demonstrated, you can plainly see the impossibility of increasing the size of structures to vast dimensions either in art or in nature; likewise, the impossibility of building ships, palaces, or temples of enormous size in such a way that their oars, yards, beams, iron-bolts, and, in short, all their other parts will hold together; nor can nature produce trees of extraordinary size, because the branches would break down under their own weight; so also it would be impossible to build up the bony structures of men, horses, or other animals so as to hold together and perform their normal functions if these animals were to be increased enormously in height, for this increase in height can be accomplished only by employing a material which is harder and stronger than usual, or by enlarging the size of the bones, thus changing their shape until the form and appearance of the animals suggest a monstrosity. To illustrate briefly, I have sketched a bone the natural length of which has been increased three times and the thickness of which has been multiplied until, for a correspondingly large animal, it would perform the same function which the small bone performs for its small animal. From the figures here shown you can see how out of proportion the enlarged bone appears. Clearly, then, if one wishes to maintain in a great giant the same proportion of limb as that found in an ordinary man, he must either find a harder and stronger material for making the bones, or he must admit a diminution of strength in comparison with men of medium stature; for if his height be increased inordinately, he will fall and be crushed under his own weight. Whereas, if the size of a body be diminished, the strength of that body is not diminished in the same proportion; indeed, the smaller the body the greater its relative strength.

Thus a small dog could probably carry on his back two or three dogs of his own size; but I believe that a horse could not carry even one of his own size.'

"*Simplicio*: 'This may be so; but I am led to doubt it on account of the enormous size reached by certain fish, such as the whale, which, I understand, is ten times as large as an elephant; yet they all support themselves.'

"*Salv.*: 'Your question, Simplicio, suggests another principle. . . .'"—And thereupon the two disputants go on to discuss the effect of immersion in water, of how by reason of its density (*corpulenza*), or, "as others would say," its heaviness (*gravitá*), the weight of bodies immersed in it is diminished; and how accordingly the body of the fish is rendered, so to speak, altogether devoid of weight, and is supported without any injury: though if a giant fish, or a great and heavy-laden ship, were drawn ashore, it would be apt to go all to pieces, crushed under its own mass.

Galileo points out that Aristotle had an inkling of the principle in that chapter of his "Mechanics" where he discusses the question, "Why a long beam is weaker than a short one"—even though the long beam be thick and the short one be thin. But at the beginning of his treatise Galileo makes it clear that he regards the general statement as a discovery of his own, and as one of great importance which moved him even to astonishment.

D'ARCY W. THOMPSON.

The Names of Physical Units.

A L'OCCASION de l'aimable analyse consacrée au "Recueil des Constantes physiques" (NATURE, May 13, p. 281), M. J.-A. Harker s'étonne de certaines expressions insérées dans le tableau dont je suis à moitié responsable, et qui sert de préface à tout l'ouvrage. Je dis "à moitié," car, à l'encontre de ceux qui se rapportent à des constantes proprement dites, le tableau des unités a été discuté et approuvé dans sa terminologie par la Commission tout entière; j'ai seulement proposé, la Commission a disposé.

Le terme *stéradian* n'a pas l'approbation de M. Harker. Evidemment, il n'est pas encore consacré par un usage international, et c'est là, peut-être, son plus gros défaut. Les physiciens français toutefois l'emploient couramment pour désigner *l'angle solide découpant, sur la sphère, une superficie égale au carré du rayon, ou l'angle solide égal au quotient de l'espace entier par* 4π. On conviendra que l'une ou l'autre de ces expressions est encombrante, et qu'une contraction était au moins désirable.

Stéradian est logique, puisqu'il résulte de l'association de radian (angle plan unité) et du préfixe impliquant la solidité ou l'espace à trois dimensions. J'ose donc espérer, malgré l'étonnement de M. Harker, voir nos confrères britanniques adopter ce terme. Ce serait une aimable réciprocité à l'hospitalité donnée par les sportsmen continentaux au mot *starter*, grâce auquel ils évitent aujourd'hui la périphrase: *Fonctionnaire chargé de donner, dans une course, le signal du départ;* tout comme le titre qu'ils s'octroient abrège cette autre appellation: *Gentlemen consacrant une partie de leurs loisirs aux exercices musculaires.*

La question du degré carré sera résolue avec celle du stéradian. C'est bien, si je ne me trompe, au moyen de cette unité que les astronomes évaluent, entre autres, l'espace de la sphère céleste que couvre un cliché photographique.

Une autre espèce d'expressions a frappé M. Harker: *masse volumique, volume massique.* Dans le tableau en question, ces expressions sont inscrites entre parenthèses, en subordination, pour ainsi dire, des termes classiques mais bien peu satisfaisants: *Densité absolue* et *volume spécifique.* Si j'avais eu une entière liberté, j'aurais certainement franchi l'étape et renversé l'ordre. Quel qualificatif, en effet, laisse plus de vague à l'esprit que celui de spécifique? On dit masse spécifique: quotient de la masse par un volume; volume spécifique: quotient d'un volume par une masse; spécifique a, ici, les deux acceptions exactement opposées, sans compter, dans d'autres cas, une foule de sens divergents. En fait, spécifique signifie tout ce que l'on veut, et par conséquent ne signifie rien du tout. La vieille terminologie laisse encore traîner dans la physique des expressions telles que *chaleur spécifique* (capacité calorifique rapportée à la masse) et *résistance spécifique* (résistance rapportée aux dimensions) et tant d'autres, pour l'intelligence desquelles le physicien est chaque fois obligé de faire appel à sa mémoire, sans aucune certitude d'être d'accord avec un confrère dans le sens à attribuer à une même expression.

Il fallait rompre un jour avec ces errements; la plupart des physiciens français, sur la proposition d'Hospitalier, ont accepté depuis des années les expressions que j'ai insérées dans le tableau, comme les mécaniciens français ont adopté, dans la technologie, des termes tels que *puissance massique,* auxquels le lecteur non prévenu ne peut se tromper, tant ils font image.

Ne pouvons-nous, au contraire, regretter de voir nos confrères britanniques conserver des expressions telles que *specific gravity,* où specific est vague et où gravity n'a rien à voir? Je soumets le cas aux méditations de M. J.-A. Harker, avec la certitude qu'il m'approuvera, car il est métrologiste, c'est à dire homme de pensée claire et concise.

CH. ED. GUILLAUME.

Pavillon de Breteuil, Sèvres (Seine et Oise), le 17 Mai.

IT would appear from the interesting letter of the Director of the International Bureau of Weights and Measures that he has a little misunderstood my reference to the new expressions he employs in the preface to the "Recueil de Constantes Physiques." If he will refer again to the review to which he takes exception, he will see that, on the matter of nomenclature, all I wrote was:—

"Some eccentricities appear in the initial table on units; few physicists are familiar with such terms as 'volume massique' and 'masse volumique,' 'degré carré' and 'stéradian.'"

I expressed no opinion as to the suitability of any of the terms in question, but only pointed out that in my view they were as yet far from familiar to the average physicist.

I have taken an opportunity of testing the accuracy of this opinion by consulting six of my colleagues. Not one of these had a clear and definite idea of the meaning of all four of the terms in question.

The introduction of a new name for a unit or an alteration in nomenclature should be a matter for the most careful consideration, particularly if it is intended for general international use; more harm than good may easily be done by an injudicious choice, even if supported by a great authority.

"Stéradian," and the other terms too, may be logical, but it is unpractical to attempt to build a language simply upon logic.

Dr. Guillaume will remember that some time after the use of the term *micron,* with its corresponding symbol, the overworked letter μ, had been introduced into metrology, as the name for the millionth part of a metre—I believe I am correct in saying, largely through the influence of Dr. Benoit—Lord Kelvin, probably unaware of this, proposed that the name *michron* be given to the millionth of a second, while he suggested that the micrometre be termed the *microm*.

Similarly, many years ago Sir Benjamin Brodie attempted to induce the chemists to rationalise their nomenclature by re-naming CO carbon*ous* oxide, and taking the name carbonic oxide for CO_2.

Had either of these proposals even partially materialised, it would undoubtedly have led to great confusion.

While to some extent I agree with Dr. Guillaume's remarks regarding the English use of "specific," I do not think he strengthens his general case by referring to "puissance massique," which, to my mind, conveys only the haziest sort of meaning.

I might point out that, according to a view I have heard frequently expressed, the general introduction of the metric system into England has been hindered by prejudice against what is considered the unnecessary number of names of units appearing in the usual books dealing with the subject. It may be desirable to have these for rare use, but it is surely inadvisable to mention them in the school books as if they were current. Thus, for example, among measures of length, one is accustomed to think in metres, centimetres, or millimetres, and of greater lengths in kilometres. The decimetre is rarely used except in connection with the litre, and the decametre, hectometre, and myriametre practically never.

In conclusion, I think I represent the views of readers of NATURE when I say that many of them will be glad to buy the French Physical Society's useful volume, if it is only to be able to get rid from their library table of one or other of the editions of its well-known predecessor, written in the language of the Huns, which at the present moment they are unable to tolerate. J. A. HARKER.

Teddington, May 25.

University Appointments in War Time.

I VENTURE to direct attention to the advertisement for a professor of organic chemistry in the University of Liverpool. It appears to me, and I believe many share my opinion, that this is a very inopportune moment for filling a university chair when eligible men are away on active service. It may seem unfitting to criticise the internal policy of another university, but it is a matter which closely affects many who have no connection with the University of Liverpool. Professors of chemistry and others are being solicited for testimonials by candidates, and in many cases such requests cannot be granted except by doing a grave and irreparable injustice to more highly qualified men who have responded to the country's call for volunteers in the present national crisis. I trust that the University of Liverpool will in this matter follow the same course as has been pursued by the University of Birmingham in the case of the vacant chair of physics, and postpone the appointment of a professor until after the termination of the war.

PERCY F. FRANKLAND,
(Dean of the Faculty of Science).

The University, Birmingham, June 12.

Volunteers for Scientific Work.

CIVILIANS of all grades are being enrolled as volunteer workers in our ammunition factories. Are there no Government chemical factories where persons of a certain amount of scientific training could render voluntary aid towards the production of chemical munitions of war? There must be many who, like myself, are beyond the fighting age, whose skilled labour might be of use at the present juncture.

EDWARD HERON-ALLEN.

Large Acres, Selsey Bill, Sussex, June 12.

SCIENTIFIC METHODS IN INDUSTRY.[1]

THE publication of this volume is opportune, for it presents data which will tend to focus attention still further upon the present unsatisfactory recognition of science by the Government and manufacturing interests of this country.

A state of war has disclosed this in detail; and demonstrated that a nation which is ill-prepared against industrial expansion in the modern sense, finds itself in an inferior position in times of war. For reasons which are still somewhat obscure, the British manufacturer has shown in the past a distinct preference towards those industries which develop best on lines of empiricism. Many have held that this is a defect; the present position has proved this to the hilt. Our manufacturers have surrounded themselves with an atmosphere which demands their whole attention in directing their ventures as they exist, manufacturing articles which depend upon a market already existing and the low selling price which always goes with such conditions. If empiricism were the only law of manufacture (as it was some fifty years ago) they would by their application outdistance all competitors.

It has been to Germany's credit that she realised the great driving force behind this system as it has been practised in the northern part of these islands, and that to turn the shield concentration in other directions was demanded, where some new factor could be introduced and the methods of empiricism were useless. British methods were not so much improved upon as superseded; scientific supervision and investigation were the beginning and end of this development; industries were built up which could not even have been started under the old *régime*; industrially useful products were in the scientific sense in many cases created, and then introduced into commerce. The older method of improving existing manufacture by empirical methods gave place to a new system. Thus the British manufacturer found himself face to face with the German industrialist, who had already convinced the German banks that he was working for a new era, where profits would be large and developments world-wide. To-day we have to consider a position where many of these new industries (by chance, or design) have been of the first importance in the time of war. The manufacture of large quantities of ammonium nitrate and nitric acid from synthetic ammonia (or the nitrogen of the air), has made Germany free from outside supplies of nitrates, and thus to some extent counteracted

[1] "First Principles of Production. A Study of the First Principles of Production and the Relation of Science to Industry." By J. Taylor Peddie. Pp. 231. (London: Longmans, Green, and Co., 1915.) Price 5s. net

our command of the sea. Extensive coke-oven plants, while tending to commercial efficiency in times of peace, have given her a supply of raw material for high explosives in times of war. Her extensive liquid chlorine plant has also been turned to notorious use.

The lesson of all this is that a nation lags behind in scientific development at a cost of a possible loss of supremacy in times of war. A state of unreadiness in this direction is co-extensive with its influence and life. Industry developed on empirical lines has a certain advantage in times of peace, for it has at its command markets of great strength and deals with large outputs, but it is one-sided. It actually leads into a backwater where adventure is suppressed in favour of mere attention to detail; the walls of the factory or works being the natural bounds of the manufacturer's interests; his energies confined within a few yards of buildings. In other words he is working in the proverbial rut. Industrially he is entirely domesticated.

It would be impossible to deny that in certain directions this system has its advantages; or that many industries are undoubtedly sound under such conditions. Also that certain phases of Empire have partly directed industry into the lines we have followed, where a large output of universal application is essential. The distressing limitations of such a system have only come to be universally recognised under the stress of war.

Now the British manufacturer is called upon suddenly to turn industrialist, and to co-operate with the scientific investigator to consider our industry as a whole. The danger of such a rapid change will be seen in the persistence of command which is essential to empiricism, as seen in the attempt to control rather than co-operate. This will only represent a transition stage, serving a purpose in the course of a radical alteration in procedure.

It is for the scientific worker to see that this intermediate stage is made as short as possible; that recognition of the work of the investigator shall be complete in all directions. This can best be achieved by taking an active interest in industrial affairs. To be merely academic will not suffice, for this offers no encouragement to the manufacturer to hold out the hand of friendship. When obliged by the circumstance of the moment to seek scientific advice he has turned to those who have technical experience rather than a studied condition of brain energy directed in the display of pure science. That a severely academic attitude has reacted against the application of science to industry is certain. The effective antidote against such a condition is a greater interest in application, as apart from theory. This can be most easily achieved by a linking up with some specific industry, which method has led many a German chemist to widen his horizon and plan of research. The effect of such a change in this country would be magical. It would react progressively both on science and industry.

The scientific worker must never forget that the business man has achieved great things for this country in the past. This is our hope for the future when he will work in partnership with the experimentalist. Such a change in attitude is an essential preliminary to a working arrangement between the interests involved. The business man will then realise that a new factor has come into his affairs. While scientific endeavour is almost entirely confined within the college walls, and recorded in the journals of learned societies, this will remain unrecognised. What is required is an active partnership between the trained investigator and those who specialise in the means of actual manufacture. The manufacturer must be convinced that certain modern industries are so bound up with experimental science that they are inseparable; that they cannot be run on the lines which were so successful in the case of the older industries.

It may even be that a thorough awakening of science is more necessary than that the business man should afford recognition. So far as chemistry is concerned, the division of those actively engaged in this science (as roughly represented by the different societies) has not altogether made for progress as a whole. Science must speak with a collective authority and with no uncertain voice. It must demonstrate by the conduct of its own affairs that it is capable of leading; that its advent into the industrial (and political) world will bring order and not chaos. At this late stage of development, the English business man will only respond to a party which exhibits by action the essential qualifications of its watchword.

Thus the passing of a certain sense of exclusiveness on the part of those who follow research is a preliminary step towards recognition by the commercial world. An advance on parallel lines is not business. Against this system we have the close association of the German method which has resulted in a solid network of endeavour.

Just so long as our advance is confined to empiricism, so long will the work of the chemist be chiefly directed towards the mere testing of material, instead of the legitimate work of developing new processes and manufacturing new materials. The war has cleared the air, and clearly points to a new path which we shall do well to follow, the common one of partnership between science and industry.

The treatment in this volume of such matters as the influence of tariffs and political economy on the industries of a country will enable the general reader to grasp certain essential factors as they are recognised to-day by the contending schools. Chapters on finance and industry, and science and industry, are equally valuable as an introduction to these complicated and involved relationships, which are so little understood in certain quarters where they should really be mastered in detail. Not the least satisfactory feature of this volume is the reprinting, with notes by Prof. R. A. Gregory, of Sir Norman Lockyer's address on the Influence of Brain Power on History, and articles on the Steel Industry by Dr. W. Lorrimer, and on the Chemical Industries by Prof. Percy Frankland.

W. P. DREAPER.

HAMPSHIRE FIELD ARCHÆOLOGY.[1]

SOME years ago Dr. Williams-Freeman undertook to make a list of "Defensive Earthworks of Hampshire" for the Hants Field Club, and when this was done, evidently with inexhaustible patience and enthusiasm, some discerning persons urged him to publish his plans and descriptions.

The resulting book is divided into three sections, a division which adds considerably to its value and has made it far more generally useful, interesting and readable.

The first section deals with the general subject of field archæology, including earthworks, ethnology, roads, the influence of the natural features of the country on the nature of the earthworks likely to be found therein, etc. The author rightly insists on Field Archæology being the *Scientia Scientarum*, that all sciences are its handmaidens, and he enumerates several. But surely in the data and results accumulated, more especially since the beginning of this century, there is *prima facie* evidence for the inclusion of astronomy as a *sine qua non* in the equipment of the Field Archæologist.

The second part of the volume deals with particular earthworks visited in the form of a day's itinerary in each chapter. Distance, direction, state of roads, possible methods of locomotion, charming descriptions of the country and places of rest and entertainment are all given, yet never obscure the primary function of the book, the description of the earthworks. The author examines quite judicially many interesting, arguable points but never becomes dogmatic; there are also many practical hints which the amateur archæologist will find invaluable. For example, the finding of a Roman coin does not *prove* that the Romans *built* the earthwork, each of which may have been successively occupied by different peoples over a long period. The close investigation of all finds is absolutely necessary from all points of view, if faulty conclusions are to be avoided. *A propos* of this Dr. Williams-Freeman relates a story concerning "Black Bar" or "Black Barrow," an oval sandhill near Linwood. Certain excavators found charcoal and Roman pottery, but as regards the latter an "old inhabitant of the district says that in his youth he used to put bits of pottery into the hill in order to get the employment of digging them out"!

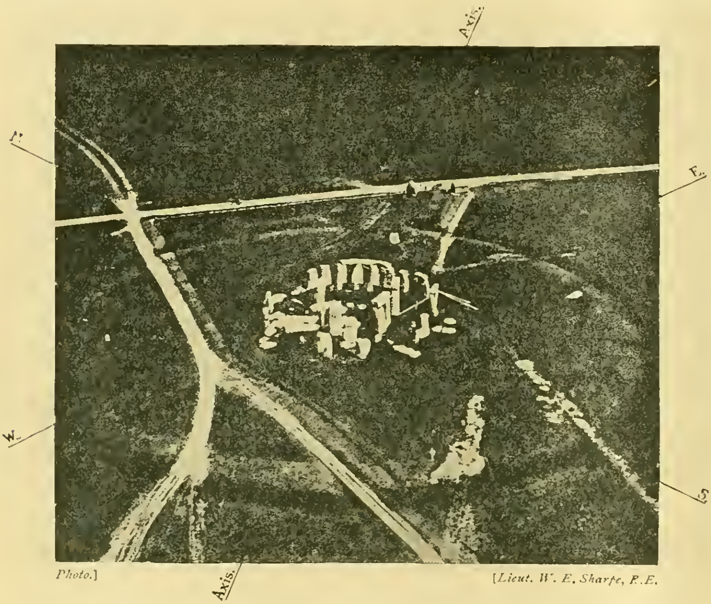

Photo.] [*Lieut. W. E. Sharpe, R.E.*

FIG. 1.—Stonehenge from a war balloon. From "An Introduction to Field Archæology as Illustrated by Hampshire."

The fifth day's journey, according to schedule, takes us from Hampshire, because, being near to Stonehenge, it would be an "unpardonable archæological sin" not to visit our most famous and grandest megalithic monument. The author carefully describes the monument and, as is his custom, judicially sifts the archæological evidence concerning its origin and date. He points out that the date astronomically determined by Sir Norman Lockyer and Mr. Penrose has been independently confirmed by two other, totally different, lines of evidence and must be accepted. But the Friar's Heel was not the index mark for

[1] "An Introduction to Field Archæology as Illustrated by Hampshire." By Dr. J. P. Williams-Freeman. Pp. xxii+462. (London: Macmillan and Co., Ltd., 1915.) Price 15s. net.

the solstitial sunrise, as he seems to believe, and will not be for centuries.

An excellent view of Stonehenge, taken from a war balloon, is here reproduced (Fig. 1).

Another interesting illustration (Fig. 2) shows an inscribed stone, believed to be the only one of its type found in Britain, which lies near the Fosbury camp, some seven miles north-by-west from Andover. This stone is covered on its flat surface with curious, irregular, waved markings, for which, so far, no satisfactory explanation is forthcoming. The author compares it with a photograph of one of the sculptured stones found at Carnac, in Brittany, and remarks on the general resemblance. While generically similar there is a marked difference, for on most of the stones we have examined at Carnac and Gavrinis there is a regularity of pattern—a concentric system of semicircles standing on a diameter—which is lacking in the Hampshire "Kenward-stone." Yet the general similarity is very striking and the problem presented, as to the purpose and meaning of the patterns, is one of great interest. There can be no question as to the artificial origin of the markings on the stones seen in Brittany, especially those in the huge dolmen on the island of Gavrinis.

Fig. 2.—The stone by Chute Causeway. From "An Introduction to Field Archæology as Illustrated by Hampshire."

Such problems as these are raised and clearly discussed throughout the book. One surprising example is the description of the much-discussed "dew ponds," or, as the author prefers to call them, "mist ponds." He states that the Wiltshire pond makers "in their invincible ignorance" always put the layer of straw—the theoretical function of which is to act as an insulating layer—*on top of the clay*, "and yet their ponds somehow hold water better than their critics' theories." Evidently the subject of "dew ponds" is not yet exhausted!

We would fain discuss this Hampshire Archæology at greater length but space forbids, and we venture to believe that, when circumstances permit, many people will wish to take the book and follow the author's most interesting itinerary, seeing and discussing.

The third part of the work is invaluable and consists of eight appendices. The first gives the author's excellent method of measuring and taking notes; numbers two and three classify and locate more than 140 earthworks, etc., examined by the author in Hampshire. In the fourth and fifth each earthwork is briefly and scientifically described in a special note, and each description is accompanied by a hachured plan (scale = 1/5,000) and a section all properly scaled and oriented: this is most valuable. Then there are very brief descriptions of "supposed earthworks," a list of "places not yet visited," and some notes on the ancient roads in the country, while at the end there is a map of the country on which are superposed the positions of the various earthworks, etc., visited by the author.

W. E. Rolston.

COTTON FOR GERMAN AMMUNITION.

THE appointment of Mr. Lloyd George as Minister of Munitions is a sign that the reconstituted Government has at length realised the serious importance of ammunition in warfare. The complement of Mr. George's work will now surely be the exclusion of materials of ammunition from our enemies. It is now many months since Mr. Runciman, President of the Board of Trade, whose special mission was to deal with commerce with the enemy, was implored to place cotton and cotton goods on the list of contraband; it was urged that only by this course could the German troops be deprived of ammunition. But the attitude of mind which induced Mr. Runciman, some years ago, in criticising Lord Roberts' efforts to bring the nation to apprehend the danger which menaced us, to wish to "apologise to our good friends the Germans," appeared to have persisted. After much pressure, the Order in Council of March 14 was issued, apparently excluding cotton. The effect was nil. Cotton still poured into Germany, as appeared from returns chronicled in the *Times* of June 10, in answer to a Parliamentary question, where enormous increases in the exports of cotton and yarns into Sweden, Norway, Denmark, and the Netherlands in the figures for April, 1915, over those for April, 1914, were reported. Imports might have been stopped at once had cotton been declared contraband of war.

It is to be regarded as most unfortunate that Sir Edward Grey, in his letter to Dr. Page on January 14, gave the promise: "His Majesty's Government have never put cotton on the list of contraband; they have throughout the war kept it on the free list; and on every occasion, when questioned on the point, they have stated their intention of adhering to the practice." It is not going too far to say that this decision has, and will, cost Britain and her Allies many thousands of lives.

The supreme tragedy of this war is that while the patriotic and unselfish citizens of the Empire are risking all to save the world from German domination, our Government has been contributing to their destruction. To fight the enemy abroad is necessary, and calls for the utmost exertion of the manliest of our race; but to have to fight an enemy at home leads us to despair of victory. Even yet, cotton is entering Germany; and I learn from French sources that African wood ("ogoubi") and Norwegian wood pulp are being tried by the Germans as substitutes. These must all be declared contraband; that step, and that step alone, will deal a final blow to the enemy.

William Ramsay.

MR. F. H. NEVILLE, F.R.S.

BY the death, in his sixty-eighth year, of Mr. F. H. Neville, at Letchworth, on June 5, the scientific world, and metallurgists in particular, have to mourn the loss of a singularly gifted man and a most charming personality. Neville took his degree in the Mathematical Tripos of 1871, when he was bracketed fifteenth wrangler. He was elected a Fellow of Sidney Sussex College, Cambridge, in the same year. The bent of his mind was, however, in the direction of experimental science rather than mathematics, and early in 1880 he took over the management of the chemical laboratory at his college.

About 1888, the work of Raoult on the lowering of the freezing points of solutions was brought prominently into notice, and it occurred to Neville and Mr. C. T. Heycock to see if the same laws applied to metallic solutions. A first paper was read before the Chemical Society on June 3, 1889, on the lowering of the freezing point of tin by the addition of other metals, in which it was shown that, as regards a metal like tin, the effect of dissolving other metals was generally the same, so far as the freezing point was concerned, as in the case of aqueous and other solutions. After the first paper was published, more extended experiments were made, great trouble being caused by the rapid shift of zero of the mercury thermometers. With the assistance of Prof. Callendar and Principal E. H. Griffiths, Neville and Heycock were able to use the platinum resistance pyrometer, and from that time the thermal work was comparatively rapid and accurate. The investigations on alloys were continued with but slight intervals up to the autumn of last year, but by far the heaviest piece of work, both thermal and microscopical, was on the alloys of tin and copper; this formed the subject of the Bakerian Lecture.

In 1897 Neville was elected a Fellow of the Royal Society. No one knows better than the present writer how large a part Neville took in all the researches with which he was jointly associated, or how he could bring a mind trained in mathematical precision to bear on his scientific work. Only those who have dealt with the complex problems of alloys can appreciate the difficulty of disentangling the maze of experimental results and sifting out the good from the worthless, and so preventing the main problem from getting side-tracked.

Those who had the privilege of knowing Neville well were aware that he was a man of many gifts and wide reading—an excellent French, German, and Italian scholar, an authority on Italian history, and deeply interested in metaphysical speculations.

A more modest man, or one who had less push, in the worldly sense, it would be impossible to find. His death has left a deep gap, which his friends know well they will never be able to fill.

NOTES.

In reply to a question asked in the House of Commons on June 14, it was announced that the Board of Trade had decided to dispense with the wool test for colour-blindness from January 1 next.

Mr. J. B. Tyrrell, of Toronto, was elected president of the Geological Section of the Royal Society of Canada at its annual meeting held in Ottawa on May 25–27.

THE Institution of Mining Engineers has awarded its medal this year to Dr. J. S. Haldane, F.R.S., in recognition of his work on the causes of death in colliery explosions and other subjects connected with mines.

WE notice with much regret the announcement that Captain J. W. Jenkinson, late fellow of Exeter College, Oxford, and University lecturer in embryology, was killed on June 4 in the trenches in Gallipoli. He was forty-three years of age.

IT is announced in the issue of *Science* for May 28 that at its annual meeting, held on May 12, the American Academy of Arts and Sciences, acting upon the recommendation of the Rumford Committee, voted: "That the Rumford Premium be awarded by the Academy to Charles Greeley Abbott for his researches on solar radiation."

A JOINT meeting of the Aristotelian Society, the British Psychological Society, and the Mind Association will be held on July 3 and 5 next. On July 3 the meeting will take place at University College, Gower Street, London, W.C., when, at 6 p.m., the annual meeting of the Mind Association will be held. Prof. G. F. Stout will contribute a paper on Mr. Bertrand Russell's theory of judgment. On July 5 the meeting will be at 22 Albemarle Street, London, W. At 4 p.m. the annual meeting of the Aristotelian Society has been arranged, and at 5 p.m. there will be a symposium on the import of propositions, by Miss Constance Jones, Dr. Bernard Bosanquet, and Dr. F. C. S. Schiller.

WE referred in NATURE of June 3 to the forthcoming sale of Stonehenge by auction. The property is under the protection of the Ancient Monuments Act, which ensures its preservation; and the auctioneers, Messrs. Knight, Frank, and Rutley, 20 Hanover Square, W., announce that Sir Cosmo Antrobus, who is only tenant for life, proposes, if his powers permit him to do so, to impose conditions providing for the public having access thereto for all time. It is hoped, however, that Stonehenge may be bought either by the Government or by a learned society, and if any reasonable proposal be made for its acquisition with the intention of preserving the monument in the public interest, the auctioneers are instructed to facilitate a sale by private treaty before the auction.

IN NATURE of May 20 we announced the death of Prof. P. Zeeman, since 1902 professor of geometry and theoretical mechanics in the University of Leyden. Prof. Zeeman was born at Hoorn (Holland) in 1850, studied in Leyden, and in 1882 became professor of mathematics at the Polytechnic School (now Technical High School), Delft, where he remained until his appointment at Leyden. He was the author of many contributions to geometry, and an admirable teacher and examiner, who won the affection of all his pupils and colleagues. Prof. Zeeman, of Leyden, has been confused with Prof. P. Zeeman, of Amsterdam. It may, therefore, be worth mention here that the professor of physics of Amsterdam is much younger than his late Leyden colleague, being born in 1865, and no near relative of the latter. Prof. Zeeman of Amsterdam also studied at Leyden, and there discovered in 1896 the magnetic separation of the spectral lines which bears his name. In 1897 he became lecturer, in 1900 professor, at Amsterdam; and in 1908 he succeeded van der Waals as director of the Physical Laboratory.

WE record with much regret the death on June 15, at eighty-six years of age, of Sir Nathaniel Barnaby, K.C.B., honorary vice-president of the Institution of Naval Architects, and formerly Director of Naval Construction. From an obituary notice in Wednesday's *Times* we extract the following particulars of his career and work. Nathaniel Barnaby entered Sheerness Dockyard as a shipwright apprentice when fourteen years old, and in 1848 gained one of the scholarships thrown open to competition among his class by the Lords of the Admiralty. He passed through the Portsmouth School with distinction, and was appointed a draughtsman in the Royal Dockyard at Woolwich in 1852. He was afterwards transferred to the Constructive Department of the Admiralty as a draughtsman; and for thirty years he remained in that department, rising to be its head in 1870, when Sir Edward Reed resigned his position of Chief Constructor. In 1872 he was definitely appointed to the position of Chief Naval Architect, a title which in 1875 was changed to that of Director of Naval Construction. In this position he continued with eminent success until 1885, when overwork caused a serious failure of health, and he decided to retire from the public service, being succeeded by the late Sir William White. After his retirement from the public service Sir N. Barnaby took, naturally, a less active part in questions of naval construction than previously. He was, however, often seen at the meetings of the Institution of Naval Architects, of which he was one of the founders, and the Transactions of which contain a number of papers from his pen, from the first volume onwards. Sir N. Barnaby was also the writer of articles of a technical character for the "Encyclopædia Britannica," and of several books on shipbuilding and naval development. He leaves a married daughter and a son, Mr. Sydney Barnaby, who holds the position of technical director and naval constructor with Messrs. Thornycroft.

AT the anniversary meeting of the Linnean Society on May 29 the following officers were elected:—*President,* Prof. E. B. Poulton; *Treasurer,* Mr. Horace W. Monckton; *Secretaries,* Dr. B. Daydon Jackson, Dr. Otto Stapf, and Prof. E. A. Minchin; *Council,* Mrs. Agnes Arber, Mr. R. Assheton, Dr. W. T. Calman, Mr. A. D. Cotton, Sir Frank Crisp, Bart., Mr. J. Groves, Prof. D. T. Gwynne-Vaughan, Prof. W. A. Herdman, Dr. B. D. Jackson, Miss G. Lister, Prof. E. A. Minchin, Mr. H. W. Monckton, Dr. C. E. Moss, Prof. E. B. Poulton, Dr. A. B. Rendle, Mr. H. Scott, Prof. A. C. Seward, Dr. A. E. Shipley, Dr. Otto Stapf, and Comr. J. J. Walker, R.N. The Trail award and medal for 1915 were presented to Dr. Leonard Doncaster, and Sir George Reid, G.C.M.G., the High Commissioner for Australia, received the Linnean gold medal for transmission to Mr. J. H. Maiden, of Sydney, New South Wales. At the general meeting of the society on June 3, the president announced that he had appointed Mr. H. W. Monckton, Dr. A. B. Rendle, Prof. A. C. Seward, and Dr. A. E. Shipley vice-presidents for the ensuing year.

The *Daily Chronicle* published on June 9 a long telegram from its New York correspondent, quoting from the New York *Tribune* the chief passages in a despatch from Mr. D. B. Macmillan, of Harvard University, the leader of the American expedition which has been at work to the north-west of Greenland since the summer of 1913. The main object of this expedition was to explore "Crocker Land," which Rear-Admiral Peary thought that he sighted from the north-west coast of Grant Land in 1906. The despatch now published was written a year ago, and the most important statement in it—that the appearance of land was seen in the direction indicated by Admiral Peary, but vanished as the explorers journeyed towards it, so that they concluded it was only a mirage—merely repeats information which was made known last winter through a despatch addressed to the American Museum of Natural History by Mr. W. E. Ekblaw, geologist and biologist to the expedition. Mr. Macmillan mentions that he has recovered records left behind by the Kane expedition and the Nares expedition. He also found in good condition milk and pemmican cached by Capt. Sverdrup twelve years ago. The work planned for this year included a journey by Mr. Macmillan himself for the exploration of the region south of the islands discovered by the Sverdrup expedition, and a journey by another party for the exploration of Greely Fiord and the Lake Hazen region in Grant Land.

The death was recently announced of M. Pierre-Emile Martin in his ninety-first year. He was the first man to solve successfully the problem of making steel in an open-hearth furnace by melting pig-iron with iron oxide and scrap steel, his first patent being taken out in July, 1865. The actual discovery that steel could be made in this way was not new, for Réaumur had in 1722 carried out the same experiment, but only on a laboratory scale. Various metallurgists afterwards endeavoured to follow this method, but none of them were able to create a sufficiently high temperature in the melting hearth. M. Martin was the first to apply the principle of regenerative heating to his furnace, and in the early 'sixties he began experimenting with a Siemens furnace of one ton capacity at Sireuil in France. After numerous failures and disappointments, he at length succeeded in producing open-hearth steel of regular quality and composition, and his process was taken up by two of the leading French steel works. The success of the process attracted the attention of his competitors, and the validity of his patents was attacked on the strength of Réaumur's prior publication, although the latter had led to no practical result. Not having the financial means to defend the lawsuits brought against him, he was compelled, after two or three years, to give up the struggle and retire into private life, and for many years his existence was forgotten, although on the Continent the process was always associated with his name. A few years ago it became known that he was alive, and in June, 1910, at a banquet held in Paris, the steel-makers of Europe united to do him honour, and he was created by the French Government an Officer of the Legion of Honour. Ten days before his death the Bessemer medal awarded him by the council of the Iron and Steel Institute was handed to a representative of the French Embassy, who attended on his behalf at the spring meeting of the institute.

At the shrine of the saint Sháh Daula at Gujrát in the Punjab the precincts of the building are occupied by a crowd of imbeciles who, from the elongated shape of their heads, are known as "Sháh Daula's Rats." Much interest has been shown in these curious creatures, and the question has been discussed whether this malformation is hereditary or artificial. In the June issue of *Man* Mr. M. Longworth Dames has collected references to the literature of the subject. From inquiries on the spot he finds them to be harmless, good-natured creatures possessing only primitive instincts and absolutely undeveloped minds. He concludes that the peculiar shape of their heads is the result of pressure applied by the mother that she may be able to devote her child to the saint to whom she owes the relief of her barrenness. He quotes an interesting account of such head-shaping from Mr. Bray's "Life History of a Brahui," and he believes, with good reason, that the practice is more common in Northern India than is commonly believed.

Of all the races of existing mankind, none is so interesting to the physical anthropologist as the Eskimo. No race possesses so many peculiar structural characters. In the last *Museum Bulletin* (No. 9, March 6, 1915) issued by the Canadian Department of Mines, Mr. F. H. S. Knowles directs attention to the peculiar form of the glenoid fossa and articular eminence in the skulls of Eskimo. The fossa is shallow, while the articular eminence is flattened and extended in a forward direction. The condition, in Mr. Knowles's opinion, is not unlike that seen in the skulls of Neanderthal man, and also, to a lesser degree, in the skulls of anthropoid apes. In most modern races of man, particularly in those living under the higher forms of civilisation, the glenoid fossa is deep and the articular eminence high and steep. Mr. Knowles seeks for an explanation of these contrasted forms of glenoid cavity in the nature of diet and in the movements of the lower jaw in mastication. As is well known, the diet of the Eskimo is particularly tough—the raw skin of whale, porpoise, and seal being looked upon as delicacies. Mr. Knowles regards the flattening of the articular eminence in the Eskimo, and also in Neanderthal man, as an adaptation to permit a free side-to-side movement of the jaw, such a movement being necessary for the proper mastication of tough substances.

We have received from Mr. Johs. Schmidt a paper, printed in the *Comptes rendus des Travaux du Laboratoire de Carlsberg*, 1915, on the amount of lupulin in plants of the hop (*Humulus lupulus*, L.) raised by crossing. Detailed accounts of the crossing experiments are given, and the results are set out clearly in tabular form; 21 English, Danish, Austrian, and

German females, all cultivated plants, were crossed with wild Danish males, and the 744 resulting seedlings were investigated. Despite the fact that the wild males were presumably poor in lupulin, offspring variants having a higher lupulin percentage than the mother plant were produced. Improvement in this direction of higher lupulin content has thus been established, since the richest plants can be vegetatively propagated.

A paper of some interest on "The Influence of Temperature and Certain Other Factors upon the Rate of Development of the Eggs of Fishes," by A. C. Johansen and A. Krogh, has been published by the International Council for the Study of the Sea, as *Publication de Circonstance*, No. 68. By means of a specially designed thermostat the authors have kept the eggs of plaice and of cod at a series of different temperatures, and have recorded the time taken until the larva has reached a certain definite length. The main conclusion arrived at agrees with that reached previously by Dannevig, who had worked with less refined methods, namely, that the increase in rate of development with the temperature is proportional to the increase in temperature, or the curve expressing the relation between temperature and rate is a straight line. The authors have also studied the influence of low oxygen pressure upon the development of the eggs of plaice.

Capt. S. A. White, the President of the Australian Ornithologists' Union, is to be congratulated in having re-discovered a long-lost bird. This is the chestnut-breasted whiteface (*Aphelocephala pectoralis*), described originally from a single specimen by the late John Gould in 1871. Since then, all search for further specimens has proved unavailing, until Capt. White found it again, in small flocks, during an expedition to the Everard and Musgrave Ranges. Judging from the plumage of immature birds which he secured, he believes that this species interbreeds with the black-banded whiteface, which is highly probable, since the two species were often found in company. Capt. White gives an interesting account of his travels in the *Emu* for April. A camel-train furnished his means of transport, but throughout no small inconvenience was suffered by all the members of the expedition, including the camels, by reason of the prolonged drought, which, save for occasional and isolated showers, has now lasted for nine years in this region.

An interesting article on the fur-bearing mammals of California, by Mr. H. C. Bryant, the game expert to the California Fish and Game Commission, appears in the April number of the new periodical, *California Fish and Game*. In a survey which dates back to 1786 the author traces the history of the ruthless and wasteful destruction of fur-bearing animals which has gone on without check until the present day. As a result some of the most valuable animals have been exterminated, while others are on the verge of extinction, a fate which can be averted only by instant and vigorous protective legislation. Among these is the sea-otter, which less than a hundred years ago was taken by the thousand; to-day no more than a few pairs are left. Some idea of the magnitude of the slaughter which is taking place may be gathered from the records of the total "catch" of last year in North America. This includes musk-rats 15,000,000, opossums 2,800,000, raccoons 2,400,000, skunks 2,152,000, minks 630,000, and "civet cats" (Bassaris) 500,000. To these must be added foxes, wolves, bears, otters, wolverines, pumas, wild cats, and martens, to the number of 1,500,000. Unhappily, the increased demand for furs is accompanied by a serious diminution in the area inhabited by the victims, owing to drainage and the destruction of forests. It is devoutly to be hoped that this appalling rate of destruction may be checked, at least, by the efforts which are being made to breed silver foxes and skunks for the sake of their skins. A number of "fur-farms" are already in a flourishing state, but so far their output is not sufficient to diminish materially the toll levied on the wild animals.

The acid secreted by the gram plant, *Cicer arietinum*, forms the subject of Bulletin No. 45 of the Agricultural Research Institute, Pusa, and has been investigated by Mr. D. L. Sahasrabuddhe. The secretion which is used as a medicine in Western India has been found to consist of a mixture of malic and oxalic acids in the proportion of 94 per cent. of the former and 6 per cent. of the latter, and the secretion appears to be produced by the glandular hairs which occur especially upon the pods. The acids are collected by drawing a damped cloth over the gram plants and then wringing it into an earthenware vessel, and during the ninth to the eighteenth week of the plant's growth the yield of malic acid for an acre of gram was found to be 2686 gm., the cost of collection being about 14 rupees.

The twisted fibres of the chir pine (*Pinus longifolia*, Roxb.) again forms the subject of an article in the *Indian Forester*. In the number for April (No. 4, vol. xli.) Mr. F. Canning deals with the matter as regards the east of Almora district. Twisting both left-handed and right-handed is found, and a very large proportion of trees are affected. At the base the twist is usually slight, and it becomes worse and worse higher up the stem, the maximum angle noted being 45° from the vertical. As to the distribution of affected trees, the relation to the geological conditions has not been observed, but aspect, fire, and proximity to villages do not appear to be correlated in any way with the occurrence of twist. Owing to the difficulty of detecting twisted trees in the young state, it may not be practicable to try to eliminate twisted fibre specimens in a sapling forest, though such trees are of very little value except for firewood.

The Salton Sea in the Cahuilla Basin of California is described and illustrated by Mr. D. T. MacDougal in the *American Journal of Science* (vol. xxxix., p. 231). The work published by the Carnegie Institution was reviewed in Nature (vol. xciv., p. 434, December 17, 1914), and this shorter account will be convenient for many who have not access to the publications of the institution.

Mr. H. P. Cushing (*American Journal of Science*, vol. xxxix., p. 288) criticises the view of Prof. W. J. Miller that the syenites and granites of the Adirondack region belong to one vast intrusive body, and maintains that here, as in Canada, there is an older group of orthogneisses which is intruded into the Grenville Series. This group has suffered severe regional metamorphism, and has been invaded by later rocks of the anorthosite-syenite group. The older orthogneisses may therefore be styled Laurentian, as in Canada.

The expedition of Mr. F. B. Loomis from Amherst College to Patagonia resulted in his discovery, published in 1914, that Pyrotherium was a proboscidean. He referred the beds in which it occurred to the Oligocene. Mr. Carlos Ameghino ("Boletin de la Sociedad Physis," vol. i., p. 446, Buenos Aires, 1914) states that certain white sandy clays underlying the Pyrotherium beds, and recognised by Loomis as Cretaceous, are the strata that contain Notostylops, Notopithecus, and other mammals. Ameghino accepts a Cretaceous age for these, and believes that Pyrotherium is an early Eocene form. If this were proved, the ancestry of the proboscideans is to be sought, as Ameghino urges, in S. America rather than in Africa.

The paper entitled "The Microspectroscope in Mineralogy," by Mr. Edgar T. Wherry, assistant curator of the division of mineralogy and petrology in the U.S. National Museum, which forms No. 5 of vol. lxv. of the Smithsonian Miscellaneous Collection, constitutes an important contribution to our knowledge of the absorptive properties of minerals. So long ago as 1866 Sir Arthur Church first noticed the existence of an absorption spectrum in zircon, but hitherto no systematic study has been made of the subject. Mr. Wherry has examined specimens of about two hundred minerals, and the results of his investigation are carefully tabulated. The analytical key given at the end of the paper should be invaluable to those making use of the method for determinative purposes. He found that better results were afforded by light diffused from the specimen than by light transmitted through it. The beautiful violet calcite from Joplin gives the neodymium absorption spectrum, and so do the yellow sphene from Switzerland and the brown apatite from Ontario. It is unexpected to learn that the colour of the violet-red almandine garnet is apparently due to vanadium. The presence of magnesium and manganese has no effect upon the colour of garnet. The bands shown by zircon are due to the presence of uranous uranium, usually in amounts of less than 0·5 per cent. The resulting blue colour is often masked by the other agents, such as iron or manganese. Brown or white zircons do not show a spectrum.

Symons's Meteorological Magazine for May gives the diurnal range of rainfall at Karlsruhe (Baden) and at Petrograd. The results have been obtained by Henrik Renqvist, Helsingfors, for the summer months June, July, and August from the published hourly values of rainfall. For Karlsruhe the observations dealt with are for twenty-two consecutive years, from 1892 to 1913 inclusive. Percentages of the total fall are given for each interval of four hours. The highest percentage value is 22·0 for 4 to 8 p.m., and the lowest 12·2 for 8 a.m. to noon. The results for Petrograd are for the twelve years 1897 to 1908, and have been dealt with in the same way. The highest percentage is 22·3 for noon to 4 p.m., and the lowest 13·3 for 4 to 8 a.m. Both stations are fair representatives of the Continental type, and show a maximum in the afternoon and a minimum in the morning. Karlsruhe is said to have a diurnal range of rainfall highly resembling that of Perpignan, for which the percentages are given. Petrograd shows great similarity to Kew, the results for which are given from "The Diurnal Range of Rain," issued by the Meteorological Council.

The *Journal of Agricultural Research*, iii., 5 (Washington), is scarcely the place in which one would expect to find a paper on fitting logarithmic curves by the method of moments. The use of logarithmic curves would appear to be desirable for tabulating biological statistics, and the object of the paper is to determine the constants when the formula assumed is of the form of a quadratic function plus a logarithm. Mr. John Rice Miner determines these constants in terms of the area and first two or three moments of the curve, but unfortunately the formulæ are very laborious in the carrying out, and it would certainly appear desirable to simplify them.

The Journal of the Washington Academy of Sciences for May 19 contains a short account of a new calorimeter due to Messrs. H. C. Dickinson and N. S. Osborne, of the Bureau of Standards. The calorimetric substance is a block of copper in which are embedded a platinum resistance thermometer and a coil of resistance wire for supplying heat to the block electrically. A number of test experiments on the specific heat of water show that a degree of accuracy of 1 part in 2000 may be obtained with the calorimeter. The specific heat between $-40°$ C. and $0°$ C. and the latent of fusion of ice at $0°$ C. have also been determined with the apparatus. The results for the specific heat are given by the expression $0{\cdot}5057+0{\cdot}00186\theta$, where θ is the temperature Centigrade, and for the latent heat 79·76 in terms of the gram-calorie at 20° C. The latter figure is in close agreement with the value 79·74 previously obtained at the Bureau by other methods, so that it seems probable that the mean 79·75 may be accepted as a close approximation to the true value of this important constant.

M. Ernest Coustet contributes to *La Nature* of May 22 a useful article on the dosage of X-rays. He admits that the mere observation of the current traversing the X-ray tube is apt to be very misleading. Better results are given by comparing the fluorescence produced by the rays with the fluorescence produced by a radium bromide standard. This method implies a careful observation of the time of exposure, a necessity which is avoided by the various "chromometers" devised by Holzknecht, Bordier, Sabouraud, and Noiré, in which the dose is estimated by the coloration of sodium chloride or bromide, or of barium platinocyanide. Since, however, the estimation of tints does not admit of any great accuracy, some ionisation method appears preferable, such as is employed in Villard's X-ray counter, in which an electroscope is discharged a number of times. It then remains to measure the "hardness" of the rays, or their penetrating power, and this may be done by Benoist's "radiochromometer," consisting of a ring of aluminium strips of twelve different thicknesses. There is still, however, much room for improved methods of dosage.

MR. JAMES KEITH directs attention in the *Engineer* for June 11 to the use of cast-iron shells of fairly large calibre by the Germans. Mr. Keith suggests that, whether or not there be any particular reason for our keeping to expensive steel shells, there could surely be no harm in our having cast-iron ones as well to fill up the gaps, and so enable innumerable shells to be at the service of the armies of the Allies. The matter is taken up by our contemporary in a leading article, and the objections to the course suggested by Mr. Keith are discussed fully. In shrapnel cast-iron shells, the number of bullets is reduced because the walls of the shell must be made much thicker. In high-explosive shells there is such danger of a cast-iron shell developing cracks during manufacture that high explosives cannot safely be used in them. Further, projectiles must be perfectly in balance; the walls must be of uniform thickness all round, and must be of homogeneous material. Otherwise accuracy in shooting would be destroyed. Lastly, the methods of manufacture of steel shell have been so developed that such shell can actually be turned out more quickly than those of cast-iron of equal trustworthiness and accuracy. An 18-pounder shell can be completely machined from the bar in about forty minutes. The *Engineer* suggests that the use of cast-iron by the Germans indicates that they are finding their supplies of modern projectiles not inexhaustible under the tremendous drain that is being put upon them.

MESSRS. LONGMANS AND CO. announce for early publication "The House Fly: a Slayer of Men," by F. W. Fitzsimons, director of the Port Elizabeth Museum. The volume will be illustrated. The author has worked for several years at the destruction of the house-fly in South Africa.

OUR ASTRONOMICAL COLUMN.

BEHAVIOUR OF SPECTRUM LINES OF THE SAME SERIES.—The lines in a series are generally assumed to behave alike (omitting reversals), even under varying experimental conditions. In fact, their sharpness, diffuseness, or direction of unsymmetrical widening have been used as criteria in the detection of series relationships. Thus if the strong lines of a series were unsymmetrically widened towards the red the remaining lines of the series would be expected to be widened in the same direction. This, however, is not the case, and an investigation bearing on these points is communicated by Dr. Royds to the forty-third Bulletin of the Kodaikanal Observatory (see also the *Astrophysical Journal*, March, vol. xli., No. 2, p. 155). In the case of the barium lines he finds that all the first members of the first subordinate series are displaced to the red, and the second members to the violet. In the case of the calcium series he finds this not so extreme a case as that of barium, but still a noteworthy exception to the general run of series. The strontium series, on the other hand, is stated to be quite normal if the infra-red lines the character of which is unknown are excepted. Dr. Royds directs attention to the whole question of the relationship between pressure shifts and series, since the pressure shift may even be in opposite directions for lines of the same series. He points out, further, the importance of isolating the pressure effect from the density effect, the elimination of the latter in order to obtain true pressure shifts being "one of the most pressing problems for those interested in the displacements in the sun's spectrum."

THE FISHER, POLK COUNTY, MINNESOTA, METEORITE.—In the *American Geologist* for December, 1894, brief mention was made of the finding near Fisher, Polk County, Minnesota, of a meteoric stone weighing nine and a half pounds. This stone, the first found within the State limits, was assumed to be a representative of a reported fall which took place on the 9th of the preceding April. In a subsequent number of the *Geologist* a petrographic description of the stone was begun by Prof. N. H. Winchell, but this was neither completed nor was a satisfactory chemical analysis made. In view of these facts and also because more parts have been subsequently found, a complete review of the whole matter has been undertaken by Prof. G. P. Merrill, and the results are published in No. 2084 Proceedings of the United States National Museum (vol. xlviii., pp. 503–6, May, 1915). It seems that specimens of this fall are distributed in eight different collections, the four largest portions being in institutions in Minneapolis, Washington, New York, and Hamburg; the total weight of all the known portions amounts to 9900 grams. The author has been offered facilities for examining and taking samples for the purposes of identification and chemical analysis, and in this paper he publishes the results of his inquiry. Following Brezina's classification he places the stone in the group of intermediate chrondites Ci, or perhaps Cia, as one cut surface shows a small thread-like black vein.

THE NANTUCKET MARIA MITCHELL ASSOCIATION.—In the thirteenth annual report of the Nantucket Maria Mitchell Association, an account is given of the astronomical work accomplished during the past year. This association completed in 1911 the Astronomical Fellowship Endowment Fund, and the first fellow was appointed in the following year; the second has just been nominated. This fellowship enables the holder to avail herself of the entire year for study and research in an observatory of her own selection. Miss Annie J. Cannon, the chairman of this special committee, describes briefly the work of the association with the new $7\frac{1}{2}$ in. photographic telescope. After the adjustments were completed numerous photographs were taken, chief of which were of the minor planet Eros. These plates are now being measured by the first fellow, Miss Harwood, at the Harvard Observatory, together with the plates of the same asteroid taken at that observatory. The chief research will be the photographing of each asteroid once a month for as long a period as possible, the selected objects being those for which the ephemeris at opposition is given in the Berlin *Jahrbuch*.

RECENT BULLETINS OF THE ASTRONOMICAL SOCIETY OF FRANCE.—The April and May numbers of the valuable Bulletin of the Astronomical Society of France have come to hand in spite of the difficulties under which such a publication is produced. The publishers, in a special note, direct attention to these difficulties, and say that the Astronomical Society of France, confident in the triumph of right and of civilisation, pursues, by the publication of this monthly Bulletin, its work of instruction and scientific propagation with untiring energy, and counts on its adherents to forward at once their subscriptions for the current year. The two issues mentioned above contain numerous communications of interest, among which may be mentioned the first observations of the transit of Mercury, an episode in the life of François Arago, an address by Monsieur C. Flammarion, delivered at the annual general meeting of the Society on April 11 of the present year, and a summary by Comte de la Baume Pluvinel, at the same meeting, of recent discoveries in astronomy. The application of selected filters to the study of Comet Delavan is described by Mentore Maggini, being a summary of a research he undertook in the year 1913.

IRON, CARBON, AND PHOSPHORUS.

DR. J. E. STEAD'S knowledge of iron-carbon-phosphorus compounds is so remarkable, and indeed so unique, that the recent meeting of the Iron and Steel Institute in London was rendered memorable by his presentation of a most illuminating paper on this subject. As a matter of fact, the word "paper" is an inadequate description of the publication, which is very composite in character and deals with some ten aspects of the iron-carbon-phosphorus equilibrium; most of them practical, some of them purely scientific.

The constitutional diagram of the iron-carbon-phosphorus alloys is not yet completely known. The studies of Stead, Wüst, and Goerens have established with sufficient accuracy the liquidus fields of that part of the triangular diagram the corners of which are represented by iron, iron phosphide, Te_3P, and iron carbide, Te_3C. The compositions of the three "binary eutectics" are known, as is also that of the ternary eutectic, which contains 91·19 per cent. of iron, 1·92 per cent. of carbon, and 6·89 per cent. of phosphorus, and freezes at about 950° C. But, in spite of the fact that the paper under notice contains much new and interesting information about some of the solid phases and their relations between the solidus and the ordinary temperature, we are still without accurate knowledge of the composition of most of them and their variation with varying temperature. The constitutional diagram below the solidus has still, for the most part, to be determined, and until this has been done the interpretation of a good many of Dr. Stead's results can only be provisional.

In some earlier experiments Dr. Stead squeezed a portion of the ternary eutectic out of grey Cleveland iron by pressure. The amount extruded, however, was only a small fraction of the total quantity present, for the mould was not maintained, as it would have had to have been, at a temperature just above the freezing-point of the eutectic. It appears, however, that the requisite temperature and pressure conditions are realised in the formation and very slow cooling of the so-called "blast furnace bears." These are accumulations of grey iron which gradually form underground below the well or crucible of the furnace, and sometimes attain an enormous size. One of these dug out from beneath one of the Skinningrove furnaces weighed between 500 and 600 tons. The circumferential contraction of this large mass on cooling compressed the central portion, which was the last to freeze. According to Dr. Stead, "the effect of this enormous pressure caused the central plastic mass to assume a vertical column, an arrangement closely resembling on a small scale the basalt of Giants' Causeway." These columns could be separated from one another. Chemical analyses indicate that about 90 per cent. of the phosphorus originally present had been extruded vertically between the columns during the period of intense compression. A "bear" with a similar columnar structure has also been found in the hearth of a Cleveland furnace of Messrs. Bolckow, Vaughan and Co. at Eston. Here, too, the columns were all vertical, and varied from $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter, and in some places were so loosely attached to each other that they could be separated by hand. These also were found to be low in phosphorus. In the case of a bear under an Ormesby furnace which had been in blast some thirty-eight years, about two-thirds of the original phosphorus had been removed, but there were no indications of columnar structure. On the other hand, the metal found in the hearth of one of the furnaces at Ferryhill consisted of columnar crystals of iron saturated with iron phosphide, with walls of iron phosphide, but entirely free from carbon and silicon. Here, therefore, the conditions must have been much more oxidising, and no ternary eutectic was present. It is, however, abundantly clear that by far the greater part of the phosphorus in highly carbonised iron is concentrated in the last portions which freeze.

Two photographs reproduced in Dr. Stead's paper illustrate the structure and mode of occurrence of the ternary eutectic extremely well. Both were developed by heat-tinting, iron phosphide appearing blue or purple, iron carbide red, and iron saturated with phosphide white. No. 1 is termed by Dr. Stead the "normal" structure, and is clearly lamellar, recalling the well-known pearlite in its form; No. 2 is evidently that of a very slowly cooled specimen, the lamellæ having coalesced to an appreciable extent.

The equilibrium relations between iron, iron carbide, and iron phosphide in the range of temperature 1000° C. to 700° C. are of the utmost importance in the light they shed on the so-called "ghosts" or "phantoms," which are very liable to occur in large forgings of mild or medium steel. These are lines or streaks which can only be detected after rough turning. As the names indicate, they are not deep-seated. They are completely removed by turning off a thin layer of the steel, but are liable to reappear in other places. It is clear, therefore, that they are very attenuated and irregularly distributed. The usual view held is that they are harmful, and forgings are sometimes rejected on account of their presence, in spite of the undoubted fact that some of them have proved satisfactory in service even though such ghost lines were present. Their occurrence, in Dr. Stead's view, is due to the fact that "in steels containing 0·45 per cent. and less carbon, although the carbon may be equally distributed when the steel is at 1000° C., on very slow cooling the ferrite first appears in the parts richest in phosphorus. The portions which are partially saturated with phosphorus cannot so readily hold in solid solution at certain temperatures as much carbon as the surrounding portions which contain little or no phosphorus; consequently, when in cooling it reaches these temperatures, the carbon diffuses out of the phosphorised parts into the surrounding pure metal." These areas of phosphide concentration constitute the ghosts, and, as sulphides and phosphides segregate together, sulphides are generally present in them as well.

Dr. Stead has succeeded in producing typical ghost lines synthetically by heating to 1000° C. strips of soft iron sandwiched with ternary eutectic and then forging down to a ¼-in. sheet. This treatment squeezed out the excess of eutectic and left the juxtaposed faces perfectly united with a thin layer rich in phosphorus. After very slow cooling, sections were cut, polished, and etched. The structure was found to consist of "strings of disconnected patches of pearlite and straight lines of ferrite," very similar to those found in ship and boiler plates. All the carbon originally present in the eutectic was found to have diffused into the iron beyond the phosphoretic junctions. Heating to 1350° C., however, followed by a three days' cooling period to 700° C., caused a uniform distribution of the carbon and phosphorus in the steel.

Dr. Stead's general conclusion is: "After careful study I am inclined to believe that if they"—*i.e.* ghost lines—"are not associated with a material amount of slag inclusions, they are not dangerous or liable to lead to the failure of engineering structures. I am led to that conclusion by submitting cross-sections to violent shock test, so that the stress applied is greater across the lines; for when this is done fracture does not start where they are located unless there are sulphide or slag inclusions in material quantity. The subject should have more consideration, and be thoroughly investigated by making suitable mechanical tests."

Only two aspects of Dr. Stead's publication have been touched upon in this article. The complete paper, however, should be studied by those who are interested in the presentation of the subject in a series of masterly and informing sub-papers which no one but he could have written.

H. C. H. CARPENTER.

THE SEISMOLOGICAL SOCIETY OF AMERICA.

FOUR volumes of the Bulletin of this society were completed with the last year. They contain many papers of interest and value, most of which have been noticed in these columns, and several —evidently the work of novices—which the Publication Committee might with advantage have suppressed.

The first part of the fifth volume, which has been issued recently, contains six papers, three of which are of general interest. Of the others, one on the seasonal periodicity of earthquakes is inconclusive. Mr. Carl H. Beal describes an earthquake which originated near the town of Los Alamos, in southwestern California, on January 11 last. This is probably the first earthquake in which the long-distance telephone has been used in the collection of records. Prof. J. C. Branner insists on the untrustworthiness of personal impressions on the direction of an earthquake-shock, and he urges that, in investigations of an earthquake, the question dealing with such impressions should be omitted. It has long been known that single observations on the apparent direction of the shock or on the fall of a column, etc., are valueless, the apparent direction being almost invariably perpendicular to the principal walls of the house in which it is observed. But the average of a large number of personal observations within a limited area has been found in several cases to coincide with the direction of the area from the epicentre. Moreover, after the Tokyo earthquake of June 20, 1894, Prof. Omori measured the direction of fall of 140 stone lanterns with circular bases in Tokyo, and the average of these measurements coincides exactly with the direction of the single great oscillation registered in that city.

The first place in the number is given to Mr. Carl H. Beal's account of the Avezzano earthquake of January 13. The material of this paper is derived chiefly from newspaper reports and from a short article which appeared in NATURE (vol. xciv., p. 565), but the author adds an interesting note with regard to the origin of the earthquake. "The higher mountain ranges near Avezzano," he says, "rise to an altitude of from 6000 to 7000 ft. and trend generally north-west and south-east, the direction apparently being determined by a series of nearly parallel fractures which extends from a region south-east of Avezzano north-west to the vicinity of Cittaducale. . . A fault is known to pass through Luco, Cappelle, Sourcola, and very close to Avezzano, and as these cities were completely demolished, it is quite probable that movement along this fracture caused the shock."

On November 8, 1914, a fairly strong earthquake was felt in central California. From the duration of the preliminary tremors at Berkeley, and from the initial times at Santa Clara and the Lick Observatory, and taking the velocity for the tremors at Zeissig's value of 6·3 km. per sec., Mr. E. F. Davis finds that the epicentre was situated on the San Andreas Rift, close to the town of Laurel. From a study of the distribution of intensity, Mr. Carl H. Beal had previously assigned approximately the same position for the epicentre. The San Andreas Rift is the great fault along which for 270 miles the movements took place which gave rise to the Californian earthquake of 1906.

Since 1832, there have, according to Mr. H. O. Wood, been twenty-five eruptions of Mauna Loa, in the south of Hawaii. With the majority of these no earthquakes are recorded, and this might also have been said of the last eruption which began on November 25, 1914, had it not been for the instrumental record of a large number of feeble shocks. Mr. Wood concludes that "nothing appears in the sequence of events which would have justified confident, or definite, *prediction* of outbreak," though the numbers of shocks recorded during the five preceding weeks were one, five, sixteen, thirteen, and thirty-eight.

C. DAVISON.

INDIAN GEODESY.[1]

THE two volumes referred to below supplement one another, for while the general report gives an abbreviated account of the year's work, more detailed descriptions and the discussions of the results obtained find their place in the Records.

Pendulum observations were made at fourteen stations between lat. 20° N. and lat. 30° N., all in the immediate neighbourhood of the 78th meridian, thus filling in the gap which existed between Lieut.-Colonel Lenox-Conyngham's work from Mussoorie to Meerut, and that of Captain Cowie in the Central Provinces. The stations include that of Kalianpur, the station of origin of the Indian triangulation, and here the pendulums were swung in the same room where Captain Basevi swung his pendulums in 1867. At Dehra Dun the new pendulum room was used. Some changes have been introduced in presentation of the results; Helmert's formula of 1901 is employed instead of that of 1884, which had been used previously; also the formula for the mass correction has been modified by taking somewhat smaller values for the mean surface density of the

1 "General Report on the Operations of the Survey of India during the Year 1912–13." By Colonel S. G. Burrard, C.S.I., R.E., F.R.S. (Calcutta, 1914.)
"Records of the Survey of India." Vol. v., Reports of Survey Parties, 1912–13. (Calcutta, 1914.)

earth and the mean density of the earth as a whole, viz.: 2·67 and 5·576, in place of 2·8 and 56·6.

In August, 1913, two members of Dr. de Filippi's Karakoram Expedition swung their pendulums at Dehra Dun, and thus a new independent value for gravity at Dehra Dun will be obtained when the expedition has returned to Genoa.

No officer being available, the determination of astronomical latitudes was not undertaken during this season.

Work was carried on in the principal triangulation, and twenty-two triangles of the Sambalpur series were observed, the standard of precision being well maintained in spite of the difficult and inhospitable character of the country traversed. A network was also observed as the control for a large-scale survey of Bombay island, and as a further stage a traverse network of considerable precision was utilised. Permanent marks were placed on brass plugs which were built into masonry a foot below ground, and a special device was introduced for accurately centring the theodolite over the mark. Linear measurements were made with a 100-ft. steel tape, which was strained by means of weights suspended over pulleys. The precision of the lines of the traverse network when adjusted to triangulated points is given as 1 in 12,000.

Some 180 miles of the Indo-Russian triangulation connection, which had been reconnoitred in the previous year, were observed, and the work satisfactorily concluded.

In levelling details are given of carrying lines, of levelling across rivers, both by the "target" and by the "vertical angles" methods, and their respective advantages are discussed.

In the winter of 1912–13 a delimitation of the boundary between Nepal State and Naini Tal district was carried out. The boundary consisting of three straight lines joining four predetermined points in forested country, it was found most convenient to run an accurate traverse near and approximately parallel to the boundary line, so that from the traverse points could be located on the boundary line, and be determined. The result was quite satisfactory, and boundary pillars were erected along the line.

Dehra Dun having been dispensed with as a meteorological station, the forenoon and afternoon observations have been discontinued, and others at 2 p.m. (standard time) have been substituted. With similar simultaneous observations taken at Mussoorie, it is hoped to gain information bearing on terrestrial refraction which will be useful in the work of the survey.

Besides the points which have been mentioned there is much detailed information of value and importance to surveyors and geodesists in these volumes, which represent a large amount of work of a high standard carried out during the period under review.

H. G. L.

THE FLY PROBLEM.

IN a pamphlet published by the Zoological Society, entitled, "The Fly Campaign," and in a public lecture delivered at the Zoological Society's offices, Prof. Lefroy has dealt with the problem of the house-fly and its allies, less from the purely scientific point of view than from the practical and economical aspect.

The pamphlet discusses flies generally, their importance and occurrence; the life-history of the house-fly is dealt with in detail; the eggs and where they are laid, the maggot, its habits, appearance, and its migration; the pupæ, the adult, its appearance, food, reproduction and the total period of its life.

A separate section describes the feeding habits of the fly, to show why and how it is such a carrier of disease, and what a repulsive intruder it is to houses; the hibernation and flight of flies is separately discussed, and a section deals with other flies than the house-fly which are found in houses.

Dr. C. J. Martin has written a section on flies as carriers of disease, which need not be summarised in view of the article on this subject in NATURE of May 13.

The pamphlet then deals with "Methods of Destruction," including the treatment of "tips" and manure, the protection of hospitals and houses, and the use of fly-traps. It concludes with a bibliography.

In his lecture at the Zoological Society's offices on June 2 Prof. Lefroy illustrated his remarks with lantern slides, largely made from the posters and illustrations used in the Fly Exhibition at the Zoological Society's gardens; these bring home vividly what flies do, how they actually feed, what the connection is between the fly feeding on human excreta and the spread of typhoid or summer diarrhœa.

In the lecture Prof. Lefroy expressed his personal opinion on many points, and especially on the question of the treatment of manure. Elaborate experiments are in progress, and already a method has been obtained which is one-third the cost of borax and water, and of far more general application. Naturally this has to be elaborately tested, but the lecturer was extremely hopeful of a solution of this problem, by far the most important in regard to the prevention of flies.

Equally elaborate experiments are in hand with regard to baits, with great promise of success; and success means a good bait that may be obtained and used in the campaign this summer.

Prof. Lefroy's lecture was illustrated by more than sixty lantern slides, many made from large wall pictures prepared for the Fly Exhibition by Miss Bertha Reid. Arrangements have been made to reproduce the lecture with the slides at any town in England that wishes it. The exhibition at the Zoological Society's gardens is popular, and will bring home to many the importance of flies and the simple ways of dealing with them.

JAMAICA AS A CENTRE FOR BOTANICAL RESEARCH IN THE TROPICS.

NO botanist should be content until he has visited some tropical area, and studied its flora on the spot. The tropical region most readily accessible from Great Britain lies in the West Indies; and as Jamaica now offers special facilities at the Cinchona station, recently leased by the Jamaican Government to a committee of the British Association, the time is opportune for explaining the advantages it can provide.

The public gardens controlled by the Jamaican Department of Agriculture are seven in number. Of these only three are botanic gardens in the strict sense, viz., the Hope Gardens near Kingston, the Castleton Garden, and the Cinchona Plantation, or Hill Gardens, in the Blue Mountains.

The first of these lies on the Liguana Plain, just beneath the foothills of the Port Royal range, at an elevation of 650 ft., and about six miles from Kingston. It comprises an area of 200 acres, with a mean annual temperature of 76° F., and average rainfall of 54·5 in. The gardens contain a large and varied collection of typical plants of the tropics, together with economic and ornamental plants, and many species of academic interest. The office, which constitutes the headquarters of the Agricultural Department, contains a good working library, and an invaluable herbarium representative of the Jamaican flora. These, together with the willing help of the superintendent, Mr. W. Harris, greatly facilitate determinations of species. The laboratories of the island chemist and of the Government micro-biologist, where, by the courtesy of the Government, reagents may be purchased at cost price, are located within easy reach of the gardens.

Castleton Garden occupies a tract of undulating ground on the left bank of the Wag-Water River, nineteen miles north-west of Kingston, on the road leading to Annotto Bay on the north coast. The average elevation of the garden is 500 ft., the annual mean temperature is 76° F., and the average rainfall 117 in. Though much smaller, and from an economic point of view less important than the principal garden at Hope, Castleton is, if anything, of greater interest to the botanical visitor. The climatic conditions are highly conducive to the growth of luxuriant vegetation; for not only is the rainfall more than twice as high as at Hope, but the atmospheric humidity is also far greater, particularly at night time, the dews being extraordinarily heavy. One of the most striking features of the garden is the collection of palms grouped artistically around a centre water-lily pond. Other families of Angiosperms that are particularly well represented are the Moraceæ, the Cæsalpinioid, and other Leguminosæ, and the Lecythidaceæ. Groups of Cycads and of Marattiaceous and Cyatheaceous ferns, bamboo-groves, clumps of tall Scitamineæ, Aroid root-climbers, and the ubiquitous epiphytic Bromeliads and epiphyllous Lichens and Hepatics are other prominent elements in a thoroughly tropical scene.

The Hill Gardens—formerly the Cinchona Plantation, and still generally known as Cinchona—are placed on one of the southern spurs of the Blue Mountains, at an altitude of 4900 ft. As the crow flies, they are about fifteen miles from Kingston, in a northerly direction; but by road the distance is somewhat greater. The scenery, especially on the latter part of the route, is beautiful in the extreme, and the vegetation varied and interesting, although up to about 4000 ft. it has been considerably modified by cultivation.

The Hill Gardens were at one time the headquarters of the botanical department, and the centre of extensive Cinchona plantations, but are now the least important, economically, of the agricultural and botanical stations maintained by the Jamaican Government. The garden proper lies on the steep terminal slope of a spur, which projects in a southerly direction from the central chain of the Blue Mountains, at a point situated nearly midway between the two high passes known respectively as Morce's Gap and Newhaven Gap. Except to the northward, where the ground rises steeply for some distance, magnificent views are obtained in every direction. Due south, one looks across the deep Yallahs valley, over the Port Royal Hills, towards Kingston Harbour, the great Palisadoes reef, which forms its natural breakwater, and the open sea. On the west and southwest, John-Crow Peak and Catherine Peak stand out prominently above many lesser hills. Eastwards, beyond the Green River valley, rise Sir John Peak (6100 ft.) and the twin summits of the Blue Mountain Peak (both more than 7000 ft.), the latter almost always wrapped in mist except at dawn.

The Cinchona dwelling-house is a substantial singlestorey building, of bungalow type, containing two sitting-rooms and four bedrooms, besides kitchen, scullery, and servants' quarters. It is this house that is now let to a committee of the British Association, and would be available for scientific visitors. It is furnished and kept in excellent repair, and is cleansed and aired at regular intervals, so as to be ready for occupation at any moment. Close by are four or five wooden sheds, two of which stand on the same terrace as the house, the rest being situated at a somewhat higher level. These were formerly utilised as offices and store-rooms, and are well adapted to serve as laboratories for morphological or physiological work. The largest shed has bench and window space amply sufficient for the needs of half a dozen workers. At present there is no supply of running water in connection with any of these outhouses, as the highest of the existing storage tanks lies approximately at the same level as the floor of the large shed, and is only connected to the dwelling-house. But it would be a simple matter to lay down a tank further up the hills, from which pipes could be carried to any of the sheds. Cinchona is fortunate in possessing an almost ideal climate. The annual mean temperature is 62° F., the mean variation only 12° F. The rainfall is high, amounting to 104 in.; but, during the summer months, at any rate, this precipitation chiefly takes the form of heavy thunder-showers, which fall in the middle of the day, and are usually followed by delightfully fresh, sunny evenings. The nights are always cool, and often indeed decidedly cold.

Like the Port Royal Hills, the Blue Mountains are, on their southern side, cultivated up to about 4000 ft.; from that level upwards they are clad in a dense covering of virgin forest which extends up to the highest summits. As already stated, the cultivation of Cinchona trees was at one time carried on upon a large scale on the slopes around the Hill Gardens. At the present day scarcely any traces of these plantations remain, and the hillsides are rapidly returning to their natural condition. A large amount of botanical material of general interest can therefore be collected in the immediate vicinity of the gardens.

A pleasant walk of three miles from Cinchona, along a level path—a rare luxury in these hills—brings one to Morce's Gap, the most frequented pass over the main ridge. Rather more than half-way from Cinchona to the gap, the somewhat scrubby growth covering the site of the old plantations gives place to evergreen dripping-forest of the most luxuriant description. The dominant trees are for the most part thin-stemmed, and of moderate stature. They are set closely together, and the leaf-canopy overhead is very dense. Hence from the greater part of the interior of this forest sunlight is altogether excluded, and even the diffuse illumination is greatly reduced. The undergrowth is on the whole markedly hygrophilous in character. It is everywhere largely composed of shade-loving ferns. In every respect, indeed, ferns constitute a very important and conspicuous element on the forest flora. Alsophilas, Cyatheas, and Hemitelias rear their splendid crowns of foliage on stems 30 or 40 ft. in height. Lomarias and Davallias climb high on the tree trunks, or straggle over the bushes. On the steep slopes are groves of the remarkable *Lophosoria pruinata*, or impenetrable thickets of Gleichenia. The numerous small stony gullies harbour many forms of special interest, such as *Marattia alata*, *Danaea alata*, and *Pteris podophylla*. Among the rich and varied epiphytic flora of these woods ferns likewise play no mean part, the Hymenophyllaceæ in particular being represented by many exquisite forms. The phanerogamic undergrowth, in so far as it consists of shrubs, is particularly rich in Rubiaceæ and Melastomaceæ; the commonest herbs are species of Peperomia and Pilea. Climbers are fairly plentiful, but few of them are woody, a notable exception being *Marcgravia umbellata*, old stems of which attain a very considerable girth. Epiphytes are exceedingly abundant, especially Bromeliads and Orchids, the former excelling in numerical strength, the latter in number of species and variety of form.

There are many excellent collecting grounds in the neighbourhood of Cinchona, such as the valley of the Mabess River to the north, Sir John Peak (both above Newhaven Gap, and below that pass, along the Latimer River), and various localities near Catherine's Peak, as well as the slopes of that mountain itself.

The preceding remarks may have served to give some idea of the merits of Cinchona from a strictly botanical point of view. There are many other places in Jamaica, such as the John Crow Mountains, Holly Mount, Mount Diablo, and, above all, the almost unexplored "cock-pit country," which are undoubtedly rich in botanical interest.

It may be worth while to point out that in regard to such considerations as personal safety and comfort, cost of living, and facilities for transport, Jamaica generally, and Cinchona in particular, compare very favourably indeed with other botanical stations in the tropics. Even in Kingston, the refreshing sea and mountain breezes, and the cool nights, render the heat quite supportable in the height of summer. In fact, Jamaica must be considered distinctly healthy, the death-rate for the whole island having been only 22 per 1000 in 1912. In the mountains there is no risk of contracting any tropical disease. Anywhere in hot countries the nature of the water supply is a matter requiring the most careful consideration. Cinchona is, however, singularly fortunate in possessing a source of drinking water which is above suspicion. The island is quite free from large carnivora and venomous snakes; indeed, the only noxious animals of any importance, apart from mosquitoes, are scorpions; although ticks are, in some seasons and localities, a source of discomfort.

The double journey, from England to Kingston and back, occupies from four to six weeks, and costs 35*l.* to 55*l.* according to the route selected. Any botanist who is prepared to set aside a summer vacation for the purpose can enjoy from seven to nine weeks in this delightful island at a total cost of well under 100*l.* The agreement recently signed for the annual tenancy of the Cinchona Bungalow between the Jamaican Government and a committee of the British Association has had the effect of making the house available for botanists and others. Application for its use may be made (with suitable credentials) to the chairman of the committee (Prof. F. O. Bower, University, Glasgow). Unfortunately, the outbreak of war during the first year of the tenure may prevent the opportunity being used. But the object of this article is to make the fact more fully known, and to show that while the scientific attractions of Cinchona are great, the risks are negligible. Cinchona is probably the safest, as it is also the nearest, point to Great Britain where a tropical flora can be studied in something approaching the virgin state; and a visit of quite useful length can easily be fitted into an ordinary summer vacation.

M. D.

THE AMERICAN PHILOSOPHICAL SOCIETY.

THE annual general meeting of the American Philosophical Society was held in Philadelphia on April 22–24. The meeting was opened by President W. W. Keen, who, with Vice-Presidents A. A. Michelson, W. B. Scott, and Prof. C. L. Doolittle, presided over the various sessions.

On the evening of April 23 a reception was held in the hall of the Historical Society of Philadelphia, at which Dr. W. M. Davis, emeritus professor of geology, Harvard University, gave an illustrated lecture on new evidence for Darwin's theory of coral reefs. The lecture described the chief results of a Shaler Memorial voyage across the Pacific in 1914, with studies of the Fiji group, New Caledonia, the Loyalty Islands, the New Hebrides, the Great Barrier Reef of Australia, and the Society Islands (see NATURE, April 15, p. 189).

On the afternoon of April 24 a symposium was held on the figure, dimensions, and constitution of the interior of the earth. The subject was discussed from the astronomical point of view by Dr. Frank Schlesinger, director of Allegheny Observatory, Pittsburgh; from the geological point of view by Dr. T. C. Chamberlin, head of department of geology, University of Chicago; from the seismological point of view by Dr. H. F. Reid, professor of dynamical geology and geography, Johns Hopkins University, Baltimore; from the geophysical point of view by Mr. J. F. Hayford, director of the College of Engineering, North-western University, Evanstown, Ill.

Abstracts of a number of the papers read during the meetings have reached us from Philadelphia, and the following brief *résumé* has been compiled from them. In the case of most of the papers, the titles alone were given in the report sent to us, but we have omitted these as not providing information of interest.

Prof. E. P. Adams, Princeton University: "The Hall and Corbino Effects."

The Hall effect is the production of a transverse difference of potential in a conducting sheet when an electric current flows through it and it is placed in a magnetic field perpendicular to its plane. The Corbino effect is the production of a circular current in a conducting disc when a radial current flows through it and it is placed in a magnetic field perpendicular to its plane. Experiments made to study the latter effect and to show its essential relation to the Hall effect are described. The symmetry of the experimental arrangement for measuring the Corbino effect, as well as the fact that the measurement of the Hall effect requires very thin sheets, gives to the Corbino effect an important position among galvano-magnetic effects.

Dr. C. F. Brush: "Spontaneous Generation of Heat in Recently Hardened Steel."

The author shows that the specimens of carbon tool steel and tungsten "high-speed" steel examined spontaneously generated a considerable amount of heat at the temperature of the room after being water-hardened at cherry-red or white heat. The development of heat at steadily diminishing rate was observable for more than a month, and was accompanied by a shrinkage in the volume of the steel. Progress of heat generation and of shrinking are shown in curves. But that shrinking is only incident to, and is not the prime cause of, the generation of heat, is evidenced by the fact that the internal work represented by the heat generated is hundreds of times greater than necessary to produce the observed change in volume. In the process of hardening, the steels increased at least $\frac{1}{2}$ per cent. in volume, as shown by specific gravity tests of $\frac{1}{2}$-in. bars and linear measurements of long thin rods. When afterwards tempered to light-blue colour, much shrinkage took place at once, and another large shrinkage when annealed. The author regards the hardened steel as being in a condition of great molecular strain, somewhat unstable at first. Spontaneous relief of a small portion of the strain causes the generation of heat observed until stability at room temperature is reached. Any considerable rise of temperature, as in tempering, permits a further spontaneous relief of strain, or molecular rearrangement, doubtless accompanied by more generation of heat, and so on until annealing temperature is reached. The process of tempering and annealing steel is exothermic, and conversely hardening is an endothermic process.

Dr. M. H. Jacobs: "Heredity in Protozoa."

In the higher animals, characters are not for the most part directly *transmitted* from one generation to the next, but develop anew in each generation from the germ-plasm. In the protozoa, on the other hand, there is a mixture of direct transmission and new development that has interesting consequences in the case of the inheritance of newly-acquired characters. In this connection a race of Paramecium with three contractile vacuoles instead of the usual number of two is discussed, and the means described by which the unusual number is kept from disappearing. The factors concerned seem to be: (*a*) direct transmission of the extra vacuole; (*b*) a tendency to adhere to ancestral racial traits; and (*c*) a new tendency of the protoplasm to produce extra vacuoles.

Prof. G. H. Parker, Harvard University: "The Problem of Adaptation as Illustrated by the Fur Seals of the Pribilof Islands."

The Alaskan fur-seal is a pelagic animal that breeds in summer on the Pribilof Islands, Behring Sea. About equal numbers of males and females are born. At the breeding age one male, the bull, becomes associated with a number of females, the cows, thus constituting a harem. A harem may contain as many as 120 cows and probably averages about thirty. As a result of this disproportionate relationship as compared with the proportion of the sexes at birth, there are to be found at most breeding grounds many so-called idle bulls. These are a measure of the inefficiency of organic adaptation. Contrary to the opinion held by many biologists, adaptation is not always a relation of great exactitude, but is often, to use the words of Bateson, a poor fit.

Dr. George H. Shull: "Heterosis and the Effects of In-breeding."

Physiological processes are stimulated and rate of growth and total amount of growth increased through the union of gametes having unlike constitution. This physiological effect of the differences in uniting gametes is heterosis. In-breeding lessens heterosis by gradually lessening the differences between the uniting gametes. The application of this principle to some of the problems of practical breeding is discussed.

Prof. Bradley M. Davis, University of Pennsylvania: "The Significance of Sterility in Œnothera."

Studies on the seed, ovule and pollen sterility in Œnothera show that there are species with a high degree of fertility and species in which fertility is low, also that hybrids may exhibit a wide range in comparative fertility. These conditions suggest the possibility that hybrids may at times continue indefinitely as impure, or heterozygous, species through a failure to produce homozygous zygotes, or through the mortality of zygotes having homozygous constitutions. *Œnothera lamarckiana* is a form with low seed fertility and a high degree of pollen and ovule sterility and may be representative of an impure species, hybrid in character, which for the most part breeds true, but occasionally and repeatedly produces other types, the so-called mutants. In genetical work with Œnotheras a method of germinating seeds must be employed which will give trustworthy proof that a culture has produced all the seedlings possible from a sowing of seed-like structures.

Dr. George F. Atkinson: "Morphology and Development of *Agaricus rodmani*.

Agaricus rodmani, which is closely related to the cultivated mushroom, *Agaricus campestris*, has a thick, double annulus, divided into an upper and lower limb by a broad, marginal groove nearly reaching the stem. This annulus, especially the lower limb, has suggested a resemblance to the volva of the Amanitas. While it arises from the surface of the pileus margin, and is composed to some extent of a portion of the blematogen, it is not strictly comparable to the volva, since the blematogen in the species of Amanita thus far studied is separated from the pileus by a distant cleavage layer, while in Agaricus it remains "concrete" with the pileus. The pileus and stem fundaments are differentiated by the appearance of an internal, narrow zone of young, slender hyphæ, rich in protoplasm, the primordium of the hymenophore and pileus margin. These hyphæ are directed obliquely downward. The rapid increase in the elements of this primordium produces a tension on the ground tissue below it, which now lags behind in growth, so that it is torn apart, forming an annular cavity in the angle between the stem and pileus. The pileus margin and the hymenophore primordium increase in a centrifugal direction. The palisade stage of the hymenophore begins next the stem. In certain individuals it also extends partly down on the stem. The hymenophore primordium consists of a zone of parallel, slender hyphæ, the ends of which are not crowded. The transition to the palisade stage occurs by the increase in number of these hyphæ and the broadening of their free ends. The lamellæ originate as radial, downward-growing salients of the palisade zone, beginning next the stem, in some individuals also arising on the upper part of the stem. Since the growth and increase of these parts of the hymenophore, as well as that of the pileus margin, is centrifugal, all stages of the young hymenophore are therefore found in a single individual during an intermediate stage of its development, the zone of gill salients next the stem, followed by the palisade zone, and outside of this the primordial zone.

E. Plaut and M. T. Bogert: "Syringic Acid and its Derivatives."

In the bark and leaves of the lilac (*Syringa vulgaris*), and in the bark of the privet (*Ligustrum vulgare*), there occurs a substance which has been called "syringin," "lilacin," or "ligustrin." When this substance is oxidised with potassium permanganate, it yields glucosyringic acid, and this latter is easily saponified to dextrose and syringic acid. The authors obtained their syringic acid by treating trimethyl gallic acid with fuming sulphuric acid, and have prepared therefrom and studied a number of new derivatives, among them being bromo-, nitro-, amino-, and hydroxy-syringic acids, esters, acetyl derivatives, and ortho-condensation products.

Prof. C. Baskerville. "The Rate of Evaporation of Ether from Oils and its Application in Oil-Ether Colonic Anæsthesia."

The rate of evaporation of oil-ether mixtures containing 25, 50, and 75 per cent. of the latter was determined at the temperature of the body. The oils used were olive, peanut, corn, cottonseed, soya bean, cod liver, and lanolin. The speed at which the ether evaporated from the 75 per cent. mixture was found clinically to be the best for introducing and maintaining anæsthesia in the human body by insertion in the colon. The technique is indicated for operations about the head, mouth, and the buccal cavity. Records are given of more than a thousand cases with different operators without a single case of post-anæsthesia pneumonia and with nausea reduced to the minimum.

Prof. Douglas W. Johnson, Columbia University: "Physiographic Features as a Factor in the European War."

The salient features of geological structure west of the Rhine and the influence of this structure upon surface topography are described. Special attention is given to the Rhine graben and the strong contrast between the steep eastern and gentle western slope of the Vosges; the maturely dissected peneplane of western Germany and the Ardennes, trenched by the incised meandering valleys of the Rhine, Moselle, and Meuse; the concentric cuestas north-east and east of Paris with their steep escarpments facing towards the Germans; and the comparatively level plains of central and north-western Belgium. In the eastern field the East Prussian lake district, the plain of Poland, the Podolian cuesta, and the Carpathian mountains are described. It is shown that in both theatres of war land-forms have exercised an important influence both upon the general plans of campaign and the detailed movements of armies. Topography limited the German invasion of France to four principal routes. The violation of Belgian neutrality had a very distinct topographic basis. Russia's plan of campaign has been dictated in part by topographic considerations, and the principal battles in the east have been fought with reference to natural lines of defence. Suggestions are made as to the effect of land-forms upon probable future movements of the armies.

Prof. Paul Haupt, Johns Hopkins University: "Opium in the Bible."

In ten passages of the Old Testament the Hebrew *rôsh*, head, denotes a bitter and poisonous plant. It is used also of the poison of serpents. According to Pliny the venom of snakes was nothing but bile. The ancients used the same word for gall, bitterness, poison, medicine. We use "to drug" for "to narcotise," although "drug" originally means simply a dry (German *trocken*, Dutch *droog*) herb. *Rôsh* is mentioned in the Bible in connection with *la'anâh*, wormwood, or absinthe. It was a plant which grew in the furrows of the fields (Hosea x. 4). The Authorised Version renders "hemlock," but *rôsh*, head, denotes poppy-head, and *mê-rôsh* is opium. Also the gall (*i.e.* bitter fluid) with wine (not vinegar) in the account of Christ's crucifixion (Matthew xxvii. 34), and the myrrh in Mark xv. 23 denote opium. The Talmud states that a cup of wine with *lebonâh* was given to criminals before their execution. *Lebonâh* means "incense," as a rule, but in this case it is used for opium. In the fifth chapter of the Third Book of the Maccabees, we read that wine with incense was given to the elephants before they were let loose upon the Jews. This "incense" may have been a preparation of Indian hemp. Assassin means intoxicated with hashish (*Cannabis indica*).

Dr. C. A. Davis: "The Occurrence of Algæ in Carbonaceous Deposits."

On account of their small size and fragile structure, Algæ have not usually been recognised as important contributors to Carbonaceous rocks, and some recent students of the microscopic structure of coals have denied the probability of their existence as fossils in Carbonaceous rocks. Under certain conditions of deposition and preservation, as yet unknown, Algæ may constitute a large percentage of the recognisable plant remains which have accumulated to form beds of Carbonaceous shales of great extent and thickness. Microphotographs of Algæ from the oil-yielding shales of Green River age were described.

Dr. W. J. Sinclair, Princeton University: "Additions to the Fauna of the Lower Pliocene Snake Creek Beds, Nebraska."

The Snake Creek beds explored by the Princeton Expedition of 1914 are found in the north-west corner of Nebraska, and consist of unconsolidated gravels and sands in which water-worn bones of a large number of fossil animals of Lower Pliocene age are found. Most of these remains are fragmentary, and there is almost no association of parts. Better material than has hitherto been collected from this formation has been secured, and new forms are now described for the first time. Most of the remains are of horses, of which there were at least a dozen different species on the Lower Pliocene plains of Nebraska, most of them three-toed. There were also several different kinds of camels, some of them quite large, at least three rhinoceroses, many carnivorous animals, some of large size, at least two mastodons, a peccary, the last of the oreodons or "ruminating hogs," an antelope of entirely new type, quite different from anything hitherto reported from North America, with scimitar-shaped horns sloping backward and curving inward, circular at the base but flattening out toward the tips. There is still another antelope, Dromomeryx, but no trace of the pronghorn. In collections made by the American Museum from the Snake Creek beds the first of the bisons appears, so the Snake Creek fauna gives us some idea of the kinds of animals on the buffalo range when the buffalo first came, and shows what great faunal changes have taken place even during the lifetime of this genus.

Prof. William H. Hobbs, University of Michigan: "The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe."

A theory of nourishment of the great continental glaciers of the polar regions is given, and the author shows in what ways this theory has been confirmed and extended by the work of numerous exploring expeditions. It is because the expeditions across Greenland of 1912 (de Quervain) and of 1913 (Koch and Wegener), and those of Scott and Amundsen into the heart of the Antarctic continent, have for the first time penetrated the central areas of continental glaciers that these studies are illuminating. The penetration of higher levels of the atmosphere upon the borders of the inland-ice through the aid of pilot-balloons has supplied further evidence of great value along a wholly new direction. Most recent of all, the studies of Sir Douglas Mawson within a new section of the Antarctic continental glacier have brought valuable confirmatory observations.

Prof. H. N. Russell, Princeton University: "Note on the Sun's Temperature."

The effective temperature of the sun may be computed from Abbot's data for the radiation of each separate wave-length, using Planck's formula. The resulting temperature at the centre of the disc is about 6600° when determined from the visible radiation, but 600° lower according to the radiation in the infra-red. The effective temperature at the edge of the sun is more than 1000° lower, which accords with the theory that at the centre of the disc we can see down deeper, into hotter layers.

Prof. R. S. Dugan, Princeton University: "Some Results from the Observation of Eclipsing Variables."

Slides were exhibited showing observed light-curves of three giant eclipsing variables: RT Persei, Z Draconis, and RV Ophiuchi; and diagrams of the binary systems the revolution of which is supposed to give rise to the observed light variations. The importance was explained of repeatedly observing the entire period shown in the discovery of shallow secondary minima, the oblateness of the stars, inter-radiation and periastron effects, and darkening towards the limb. Evidence was given of the greater brilliance of the advancing side of the bright star. The variation of the periods of these three stars was described. Early Harvard photographs and recent photometric observations extend the observations of Z Draconis over nearly 7000 periods and of RT Persei over nearly 11,000 periods. Visual and photographic light-curves were compared.

R. J. McDiarmid: "The Variable Stars TV, TW, and TX Cassiopeiæ."

A brief discussion of the light-curves of the variable stars TV, TW, TX Cassiopeiæ and T Leonis Minoris was given, pointing out interesting features in connection with each system. In the system TV Cass. we have two stars of nearly the same size but of different surface brightness, the ratio being 5·5 to 1·0. In this system other points of interest are brought out, such as the reflection and ellipticity effects. The system TW Cass. represents two stars of almost equal brightness and of nearly the same size, moving in an eccentric orbit. In the third system TX Cass. the two stars are very unequal in size with a ratio of surface brightness of 1·0 to 1·5. The stars are ellipsoidal in shape, giving rise to an ellipticity effect shown by the light-curve. The system is of special interest, as there seems to be little doubt of its being similar to the sun, bright at the centre, decreasing in brightness towards the limb. T Leonis Minoris is an eclipsing variable. The ratio of the surface of the two stars in the eclipsing system T. Leonis Minoris is 1 to 25.

Dr. Edwin B. Frost: "Radial Velocities in the Orion Nebula."

The investigations of the nebula in Orion by Messrs. Bourget, Fabry, and Buisson, of Marseilles, published in the *Astrophysical Journal* for October, 1914, show that the photographic interferometer method can be applied successfully to the study of the radial velocities of the nebula, both as a whole and in its separate parts. Their conclusion that there are appreciable motions in closely adjacent portions of the nebula have been confirmed by observations made recently with the Bruce spectrograph. Differences of more than 10 km. per second in the velocity in the line of sight have been found, and the general effect of rotation of the nebula inferred by the French observers is confirmed by the spectrograph.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The council has decided that in the existing circumstances of national stress the ordinary annual degree congregation with its attendant ceremonial and festivity would be inappropriate. All degrees this year will therefore be granted *in absentia*.

Dr. T. Sydney Short has been appointed Ingleby lecturer for 1916, and Dr. Douglas Stanley has been appointed honorary examiner for the Russell Memorial Prize for the current year.

THE Board of Trinity College, Dublin, has appointed Miss E. M. Maxwell, of the Royal Victoria Eye and Ear Hospital, Dublin, to the Montgomery lectureship in ophthalmology, the establishment of which was announced in NATURE of February 25 last.

WE have received from Washington a copy of the report of the librarian of Congress and of the superintendent of the library building and grounds for the financial year ending June 30, 1914. It is interesting to note that in 1897 the library comprised about 850,000 printed volumes and pamphlets and about 500,000 other articles—manuscripts, maps, and prints; and a staff of forty-two persons. The grants for the purchase of books was 6000*l*. a year, and for printing and binding 5000*l*. At the date of the report the grant for the purchase of books had increased to 20,000*l*., the staff in the library proper was 385, and the number of books had reached two millions, and the other articles another million. In other words, the collection is now in size third among those of the world. We have also received from the Library of Congress a catalogue of the publications issued by the library since 1897.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 3.—Sir William Crookes, president, in the chair.—Prof. C. H. **Lees**: The shapes of the equipotential surfaces in the air near long buildings or walls, and their effect on the measurement of atmospheric potential gradients. The shapes of the equipotential surfaces are determined, and the equipotential lines drawn to scale in the following cases:—(1) A thin vertical wall; (2) a retaining wall separating a lower from a higher horizontal plane; (3) a series of equidistant parallel vertical walls. In each case the normal vertical potential gradient may be calculated from observations of the potential at any point. A point on each wall is indicated at which the horizontal potential gradient is identical with the normal vertical gradient.—Prof. O. W. **Richardson**: The influence of gases on the emission of electrons and ions from hot metals. As is well known, the thermionic saturation current i is expressed accurately and quite generally over wide ranges of temperature by the equation $i=AT^{\frac{1}{2}}e^{-b/T}$. In the case of metals, in particular, the equation is satisfied when the metals are contaminated by the presence of a gaseous atmosphere, as well as when the surfaces of the pure metals are tested. In general, however, the effect of the contaminating gas is to cause large changes in the values of the constants A and b. The changes which are thus brought about in these constants are considered in the present paper. So far as it may be considered trustworthy, the available evidence shows that A and b for a given metal always change together in such a way that the change in $\log A$ is proportional to the change in b. This linear relation is very closely satisfied by the results of all Langmuir's observations with tungsten, for which substance different gases change A by as large a factor as 10^{12}. A similar relation, with an almost equal coefficient of proportionality, is required by the best observations on the negative emission from platinum. In the case of tungsten, contaminants cause an increase in A and b, whereas with platinum a diminution occurs. All the known data point to the existence of a similar law governing the steady emission of positive ions from platinum. By applying thermodynamic considerations to the emission of electrons from contaminated surfaces, it is shown to follow from the linear relation between $\log A$ and b, that the contact potential difference between the pure and the contaminated metal is of the form $a_0(1-aT)$, where the constant a_0 has opposite signs for tungsten and platinum, and a has approximately the same value for both metals. T is the absolute temperature.—Prof. J. W. **Nicholson**: The band spectrum associated with helium. Fowler has concluded recently that the heads of the bands in the new spectrum associated with, and perhaps due to, helium follow laws of the type hitherto peculiar to line-series. A further examination of some points which were in doubt has been made with the following results:—(1) The paper supports the conclusion that the heads of the bands in the spectrum of Goldstein and Curtis follow ordinary series laws by showing that the doublet separations actually tend to zero at the limits of the series; (2) both the doublet series isolated by Fowler are strictly analogous to principal series in line-spectra; (3) the generalised Rydberg formula, in which the wave number is a function of $m+\mu$, gives the most suitable representation of these series as well as of line-series.—C. **Dobell** and A. P. **Jameson**: The chromosome cycle in Coccidia and Gregarines. The authors have investigated the chromosomes of a coccidian (*Aggregata eberthi*) and a gregarine (*Diplocystis schneideri*). They have found that the chromosomes are present in the haploid ("reduced") number—six in Aggregata, three in Diplocystis—at every nuclear division in the life-history except that of the zygote nucleus. This nucleus contains the diploid number of chromosomes—twelve in Aggregata, six in Diplocystis—and its division is a reduction division which halves the chromosome number. Reduction thus occurs in these organisms immediately after fertilisation, and not during gametogenesis.

Mathematical Society, June 10.—Sir Joseph Larmor, president, in the chair.—Prof. W. **Burnside**: Periodic irrotational waves at the surface of deep water.—Prof. M. **Kuniyeda**: A theorem on series of orthogonal functions.—G. R. **Goldsbrough**: The effect on the tides of the variation in the depth of the sea.—Prof. D. **Buchanan**: Oscillations near an isosceles triangle solution of the problem of three bodies, as the finite masses become unequal.

BOOKS RECEIVED.

The General Theory of Dirichlet's Series. By G. H. Hardy and Dr. M. Riesz. Pp. 78. (Cambridge: At the University Press.) 3*s*. 6*d*. net.

The Soul of the War. By P. Gibbs. Pp. 362. (London: W. Heinemann.) 10*s*. 6*d*. net.

Elementary Experimental Statics. By I. B. Hart. Pp. vii+200. (London: J. M. Dent and Sons, Ltd.) 2*s*. 6*d*.

The People of India. By Sir H. Risley. Second edition. Edited by W. Crooke. Pp. xxxii+472+plates xxxv. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 21*s*. net.

Making the Most of Life. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix+298. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 3*s*. 6*d*.

The Statesman's Year-Book, 1915. Edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. Pp. lxxxiv+1536. (London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

Petroleum Technologist's Pocket-Book. By Sir B. Redwood and A. W. Eastlake. Pp. xxiv+454. (London: C. Griffin and Co., Ltd.) 8*s*. 6*d*. net.

Refuse Disposal. By Prof. E. R. Matthews. Pp. xiii+160. (London: C. Griffin and Co., Ltd.) 6*s*. net.

The Tokyo Imperial University Calendar, 1913–14. Pp. vi+349. (Tokyo: Maruya and Co.)

DIARY OF SOCIETIES.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.—Analyses of Agricultural Yield. II. The Sowing-date Experiment with Egyptian Cotton, 1913: W. L. Balls and F. S. Holton.—Soil Protozoa and Soil Bacteria: E. J. Russell.—The Enhanced Series of Lines in Spectra of the Alkaline Earths: Prof. W. M. Hicks.—Certain Linear Differential Equations of Astronomical Interest: Prof. H. F. Baker.—The Partial Correlation-Ratio: Prof. Karl Pearson.—The Effect of Temperature on the Hissing of Water when flowing through a Constricted Tube: S. Skinner and F. Entwistle.—Ionisation Potentials of Mercury Cadmium and Zinc and the Single and Many-lined Spectra of these Elements: J. C. McLennan and J. P. Henderson.—A Diagram to Facilitate the Study of External Ballistics: Prof. W. E. Dalby.—The Monoclinic Sulphates containing Ammonium. Completion of the Double Sulphate Series: Dr. A. E. H. Tutton.—And other papers.

LINNEAN SOCIETY, at 5.—Colonel Montagu, Naturalist: Bruce Cummings.—The Fibre of *Calotropis procera*, and the Cultivation of the Plant from an Economic Point of View: Dr. George Henderson.—The Structure of the Rhiz pod Test: John Hopkinson.—Medusæ from the Indian Ocean, collected in 1905. E. T. Browne.—Report on the Hexactinellid Sponges (Triaxonida) collected by H.M.S. *Sealark* in the Indian Ocean. Prof. A. Dendy.—The Cephalopoda obtained by the Percy Sladen Trust Expedition to the Indian Ocean in 1905: J. C. Robson.

MONDAY, JUNE 21.

VICTORIA INSTITUTE, at 4.30.—Annual Address: The Unity of Genesis. Prof. H. Edouard Naville.

WEDNESDAY, JUNE 23.

GEOLOGICAL SOCIETY, at 8.—A New Eurypterid from the Belgian Coal Measures: Prof. Xavier Stainier.—A Fossiliferous Limestone from the North Sea: R. B. Newton.—The Origin of the Tin-ore Deposits of Kinta District, Perak (Federated Malay States): W. R. Jones.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY, at 5.—A Theory of the Electrical Resistance of Metals: Sir J. J. Thomson.—An Unbroken Alternating Current for Cable Telegraphy: Lt.-Col. Squier.

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THURSDAY, JUNE 24, 1915.

CHEMISTRY OF PETROLEUM.

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

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

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

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

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

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

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

J. B. C.

SIGNIFICANCE OF SEXUAL REPRODUCTION IN PLANTS.

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

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

The origin of sex was marked by the appearance of minute, motile gametes—reproductive cells that pair and fuse. If the material of a protoplast is divided only a few times there is spore-formation; if the divisions are more numerous the cells produced are probably gametes. Perhaps the ageing of cells stimulates the numerous divisions and the production of cells incapable of functioning as spores. Whether the pairing gametes appear similar (isogamy) or dissimilar (heterogamy) there is certainly physiological unlikeness. They are the bearers of sex-determiners and corresponding sex-inhibitors, which are passed on through generations of vegetative cells until conditions favour their expression in gamete-formation again. It is a mistake to suppose that nutrition determines sexuality, but it sometimes determines the opportunity for the expression of sexuality. Similarly, the nutritive supply is not necessarily related to differentiation of sex or size. The male gametophyte of Equisetum is small because it is a male, and not male because it is small.

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

CASE-HARDENING.

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

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

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

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

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

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

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

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

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

H. C. H. Carpenter.

OUR BOOKSHELF.

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

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

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

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

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

Cecil H. Hooper.

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

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

W. D. H.

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

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

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

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

LETTERS TO THE EDITOR.

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

The Mobilisation of Science.

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

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

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

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

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

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

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

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

T. K. Rose (President).

Institution of Mining and Metallurgy, June 19.

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

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

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

A. L. Cortie.

Stonyhurst College Observatory, June 20.

Man's True Thermal Environment.

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

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

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

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

G. W. Grabham.

Khartoum, May 26.

A Continuous Spectrum in the Ultra-Violet.

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

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

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

James Barnes.

The University, Manchester, June 19.

The Names of Physical Units.

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

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

Teddington, June 19.

Training for Scientific Research.

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

Organic Chemistry Department, University of Glasgow, June 20.

Extinguishing Fires.

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

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

June 14.

THE SYNTHETIC PRODUCTION OF NITRIC ACID.

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

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

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

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

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

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

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

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

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

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

THE ROYAL DUBLIN SOCIETY.[1]

THE history of the Royal Dublin Society is that of an extensive and efficient group of educational institutions, which still cluster, in appropriately classical buildings, round about the residence of the Dukes of Leinster. The founders of the "Dublin Society" in 1731 were anxious to improve in every way the condition of Ireland, by encouraging "husbandry, manufactures, and other useful arts." The atmosphere of Dublin was at that date eminently progressive. London was reached by a drive to Dalkey Sound, a crossing of very doubtful duration in a sailing-packet to Anglesey, and a journey of some days by chaise and coach, including the troublesome passages of Beaumaris sands and Penmaenmawr. London, moreover, was then a city to be rivalled rather than envied, and the Irish capital became adorned at this period with the handsome public buildings which remain its chief glory at the present day. Wealthy residents occupied town-houses, decorated internally in the most exquisite Georgian taste; among these, Lord Kildare, afterwards first Duke of Leinster, built a mansion on the eastern margin of the city in 1745. In 1814 the Royal Dublin Society purchased this building, and obtained a habitation worthy of the position it had gained (Fig. 1).

Thus, by private enterprise, a great institution for the promotion of applied science had grown up in Dublin. It must be remembered, however, that its members had considerable influence; they included a large part of the Irish House of Lords, and the meeting for the first election of members, in 1750, after the society had received its royal charter (p. 76), was held in the Parliament House in College Green. The Irish Parliament (p. 209) was always ready to acknowledge and assist the work of the society, and—though Mr. Berry does not mention the fact—the purchase of the Leskean collection of minerals for the benefit of Irish students (p. 156) was made possible by the zeal of the Speaker, John Forster, and by a vote from public funds.

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

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

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

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

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

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

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

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

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

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

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

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

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

DR. J. W. JENKINSON.

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

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

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

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

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

NOTES.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

OUR ASTRONOMICAL COLUMN.

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

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

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

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

AIMING WITH THE RIFLE.

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

An experimental arrangement which can be used to illustrate the essential difficulties to be met with in aiming with the rifle, is represented in perspective in Fig. 1. A is a rough model of the eye. It comprises a tube about $1\frac{1}{2}$ in. in diameter and 3 in. long, closed in front with a lens L of about 3 in. focal length; into the back of this tube fits another tube, which carries a screen of ground glass S. B is a sheet of cardboard, with a notch in the upper edge, to represent the rear-sight of the rifle. C is a piece of card cut to a point, to represent the fore-sight of the rifle. D is a circular opaque disc which, for convenience, may be attached to the glass of a window of the room in which the experiment is conducted; this disc represents the "bull's-eye" of the target. By sliding the screen S in or out, either B, C, or D may be focussed; but all cannot be focussed at the same time. If, however, the lens is covered with a piece of card provided with a circular aperture of about $\frac{1}{8}$ in. diameter, A, B, and C can all be focussed simultaneously; and the screen S can be moved in or out through some distance without impairing the clearness of the image on the ground glass. The brightness of the image is, however, much diminished. This illustrates the advantage and disadvantage due to the use of "pin-hole" spectacles. If the card is arranged so that its circular aperture lies over the

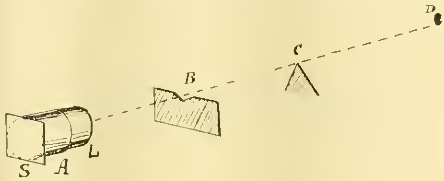


Fig. 1.

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

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

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

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

The following important phenomena can also be noticed:—

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

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

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

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

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

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

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

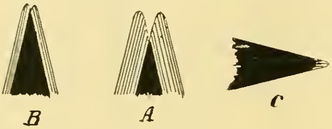
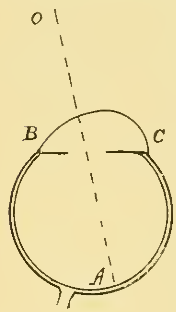


FIG. 2.

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



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

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

So far as the lighting of indoor ranges is concerned,

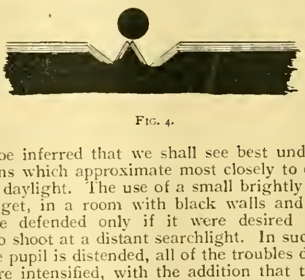


FIG. 4.

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

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

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

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

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

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

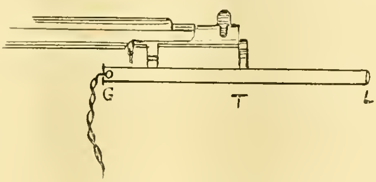


FIG. 5.

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

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

THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

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

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

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

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

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

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

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

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

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

OSMOTIC PRESSURE AND THE PROPERTIES OF SOLUTIONS.

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

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

A similar remarkable agreement has been obtained in a final series of measurements, made under the most highly perfected experimental conditions, of the osmotic pressure of solutions of glucose at 30°, 40°, and 50° C. Twenty-four measurements are recorded, in which the average value of the ratio of osmotic pressure to gas pressure was exactly 1·000, and the average error less than ±0·001. In the case of mannitol at five or six concentrations, and at temperatures from 10° to 40°, the average ratio was $1{\cdot}000_5$, and the average error $\pm 0{\cdot}001_1$, showing that within the limits thus far investigated, aqueous solutions of mannitol obey the laws of Gay-Lussac and Boyle.

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

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

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

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

ELECTRONS AND HEAT.[1]

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

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

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

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

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

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

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

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

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

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

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

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

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

Values of Latent Heat of Emission Reduced to Equivalent Temperatures.

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

Tungsten (Langmuir) ...	$10 \cdot 5 \times 10^4$—$11 \cdot 1 \times 10^4$	calor[illegible]	
,, (K. K. Smith)	$10 \cdot 94 \times 10^4$	,,	,,
Platinum (various) ...	12×10^4—16×10^4	,,	,,

(2) From cooling due to emission:—

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

(3) From heating due to condensation:—

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

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

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

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

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

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

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

where R is the constant in the equation $pv = RT$ of a perfect gas, and Q is the quantity of electricity which liberates half a cubic centimetre of hydrogen at 0° C. and 760 mm. in a water voltameter. The requirements of this formula are found to be fully satisfied by the results of the experiments. Thus the logarithms of the ratios of the currents are found to be accurately proportional to the differences in the corresponding opposing potentials at a given temperature. Again, since Q is a well-known physical constant, and the value of T was estimated during the experiments, we can use the experimental data to obtain a value of the gas constant R. Eight experiments, made under conditions as varied as possible, when treated in this way, gave values of R which varied between the extreme limits $3 \cdot 08 \times 10^3$ and $4 \cdot 46 \times 10^3$ ergs per c.c. per degree C. These values exhibit a rather wide variation, which, however, is believed to be fortuitous; so that the mean value should be much more accurate. The mean of the eight values gives $R = 3.72 \times 10^3$, whereas the number given by the gas equation is $R = 3.711 \times 10^3$ in the same units.

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

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

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

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

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

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

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

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

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

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

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

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

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

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

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

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

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

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

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

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

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

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

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

SOCIETIES AND ACADEMIES.

LONDON.

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

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

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

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

Royal Meteorological Society, June 16.—Prof. H. H. **Turner**: Discontinuities in meteorological phenomena. Meteorological history is divided into "chapters" averaging $6\frac{1}{3}$ years long, with abrupt changes (or "discontinuities," as the author calls them) between. The dates of change are apparently settled by the movement of the earth's axis. They oscillate about mean positions in a cycle of 40·5 years, which appears in Brückner's collected "cold winters" for 800 years; in Nile flood records for 1000 years; and in measures of Californian tree rings for 520 years. The chapters are alternately hot and cold, wet and dry, as shown by rainfall and temperature records at Greenwich, Padua, and Adelaide.—C. **Harding**: Battle weather in western Europe, nine months, August, 1914, to April, 1915. The author briefly described the weather conditions bordering on the battle area of the western front. At the commencement of the war generally bright and dry weather prevailed, with occasional short spells of rain, but from mid-October to the end of February rainy and rough weather continued with but little cessation. Taking widely distributed stations over the British Isles, it was shown that the rainfall for the nine months in the north and west was below the average, but in the south and south-east it greatly exceeded the normal. With the western Continental stations the rainfall for the same period was everywhere excessive. The author says:—"It is not suggested that in the recent wet weather the rainy conditions have been generated by gun-firing, but it seems quite possible that at times, when the conditions are favourable to rain, the rains have been augmented or accelerated by the concussion initiated over the battle-grounds."

Dublin.

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

Paris.

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

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

BOOKS RECEIVED.

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

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

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

Whitby Wild Flowers. By B. Reynolds. Pp. 60. (Whitby: Horne and Sons.) 1*s*.

Educative Geography. By J. L. Haddon. Pp. 76. (London: G. W. Bacon and Co., Ltd.) 1*s*. net.

Memoirs of the Indian Meteorological Department. Vol. xxi. Part x. Correlation in Seasonal Variations of Weather. iv., Sunspots and Rainfall. By Dr. G. T. Walker. Pp. 17–59. (Simla: Government Central Branch Press.) 1.8 rupees.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. iii. Part 2. Pp. 23–44+4 plates. (Sydney: W. A. Gullick.) 2*s*. 6*d*.

Field Book of American Trees and Shrubs. By F. S. Mathews. Pp. xvii+465. (New York and London: G. P. Putnam's Sons.) 7*s*. 6*d*. net.

Genetic Theory of Reality. By Dr. J. M. Baldwin. Pp. xvii+335. (New York and London: G. P. Putnam's sons.) 7*s*. 6*d*. net.

The Chemist's Year Book. Edited by F. W. Atack. 2 vols. Pp. 914. (London and Manchester: Sherratt and Hughes.) 10*s*. 6*d*. net.

The Investigation of Mind in Animals. By E. M. Smith. Pp. xi+194. (Cambridge: At the University Press.) 3*s*. net.

St. Bartholomew's Hospital in Peace and War. By Dr. N. Moore. Pp. iv+56. (Cambridge: At the University Press.) 2*s*. net.

A Report on Researches on Sprue in Ceylon, 1912–14. Pp. x+155. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

A Map of the Western War Area. From the Seine to the Rhine, and from the Swiss Frontier to the Rhine Delta. With Contour Lines and Layered Colouring. Style B. Mounted in Sections, without Names. (Oxford: University Press.) 12*s*. 6*d*. net.

Our British Snails. By Rev. Canon J. W. Horsley. Pp. 69. (London: S.P.C.K.) 1*s*. net.

The Beothucks or Red Indians: the Aboriginal Inhabitants of Newfoundland. By J. P. Howley. Pp. xx+348+plates xxxvii. (Cambridge: At the University Press.) 21*s*. net.

The Evolution of the Potter's Art. By T. Sheppard. Pp. xx. (London: A. Brown and Sons, Ltd.)

DIARY OF SOCIETIES.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY, at 5.—A Theory of the Electrical Resistance of Metals: Sir J. J. Thomson.—An Unbroken Alternating Current for Cable Telegraphy: Lt.-Col. Squier.

MONDAY, JUNE 28.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Map of Europe and the Near East, compiled by the Society for the General Staff: A. R. Hinks.

FRIDAY, JULY 2.

GEOLOGISTS' ASSOCIATION, at 8.—A Provisional Hypothesis to Explain the Occurrence of the Various Types of Fossil Man: Prof. A. Keith.

SATURDAY, JULY 3.

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

MONDAY, JULY 5.

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

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THURSDAY, JULY 1, 1915.

PHYSICAL, CHEMICAL, AND ENGINEERING CONSTANTS.

Tables Annuelles de Constantes et Données Numeriques de Chimie, de Physique et de Technologie. Volume ii., Année 1911. Pp. xl + 759. Price 28*s.* 6*d.* net. Volume iii., Année 1912. Pp. lii + 595. (Paris: Gauthier-Villars et Cie.; London: J. and A. Churchill, 1914.) Price 28*s.* 6*d.* net.

THESE volumes are a continuation of the new annual tables of physical, chemical, and engineering constants, the publication of which was commenced by an influential International Committee in 1910; they contain the data for the years 1911 and 1912 abstracted from a very large number of scientific periodicals. One of their most commendable features is that memoirs are not passed over even when their titles do not indicate them as sources of new constants. The abstractors have indeed no light task in the collection of the large amount of information constituting in a single volume the results of a year's research by the laboratories of the entire world. While the basal language of the book is French, the preface, headings to the pages, and the excellent indexes are also printed in English, German, and Italian.

When the first volume of these "Tables Annuelles" was published one was inclined to look forward with dismay to the prospect of being obliged when requiring a physical constant to search for it not only in some general book of tables, but in a series of volumes, increasing in number each year. But during the short time which has elapsed since their publication, they have become indispensable to every well-equipped science library, it being understood that their use is supplementary to that of one or more of the standard works of reference. It may be of interest to point out that since the issue of vol. i. there have been published of works on physical constants the large work of the late Mr. Castell-Evans, the useful small book of Kaye and Laby, and the fine volume issued by the Société Française de Physique, edited by Profs. Abraham and Sacerdote; also a new edition of "Landolt and Börnstein," more bulky than ever, and two new editions of the well-known Smithsonian Tables, in the last of which the rather numerous printer's errors occurring in its predecessor have been corrected.

The two volumes under review bear signs that the experience gained by the compilers has enabled them to introduce a number of improvements, and a careful examination of the books has revealed only comparatively few errors.

One of the latter is that experience with an electrically heated salt-bath, employing a mixture of KCl and NaCl, indicated that Mr. Dutoit's figures on page 518 of vol. ii. for the conductivity of these mixtures at the higher ranges are given a hundredfold too great; $K \times 10^8$ at the head of the column should apparently be $K \times 10^6$.

The staggering statement on page 408 of the same volume that Cambridge tap water contains 135×10^{12} grams of radium per litre would, if true, delight the heart of many others besides Sir J. J. Thomson and Mr. Satterly. Obviously 10^{12} should be 10^{-12}.

A list of a few other inaccuracies has been sent to the compilers. In spite of these almost inevitable slips we have little fault to find with the volumes, the general usefulness of which is undoubted.

In vol. ii. the division relating to spectroscopy, consisting of more than 150 pages, is unusually complete. No fewer than 30 pages are devoted to the Zeeman effect alone, while the results of the work of King, of Duffield, and of Rossi on the effect of pressure are tabulated in detail.

In vol. iii. the ground covered seems to have been still further extended, large physiological and biochemical sections being added. It would not, however, be safe to presume that though one finds on page 488 "Lait—Densité 1·0270–1·0326" the heading a few pages later, "Propriétés des Laitiers" (page 530), implies that the milkman also has been included.

The volumes indicate how great is the progress now being made by research, and render much otherwise difficultly accessible material very generally available.

The compilers kindly offer in the preface to vol. iii. to place their services at the disposal of readers requiring further information as to data in periodicals to which they have not access.

In view of the necessarily bulky character of these volumes an excellent innovation is the issuing of a number of the more important sections of vol. iii. in separate parts. A reader can thus acquire the advantages of possessing the data on the portions in which he is specially interested, without being obliged to buy the whole work.

In conclusion, we venture to hope that the idea of the committee of issuing every five years or so a *critical* summary volume, in which an attempt will be made to sift out the wheat from the chaff and assess the relative value of the various discordant determinations, will not be lost sight of. The need for it becomes continually more apparent.

J. A. HARKER.

ELEMENTARY ZOOLOGY.

(1) *Zoology: An Elementary Text-Book.* By Dr. A. E. Shipley and Dr. E. W. MacBride. Third edition. Pp. xx+752. (Cambridge: At the University Press, 1915.) Price 12*s*. 6*d*. net.

(2) *Elementary Text-book of Economic Zoology and Entomology.* By Prof. V. L. Kellogg and Prof. R. W. Doane. Pp. x+532. (New York: H. Holt and Co., 1915.) Price 1.50 dollars.

(1) A NEW edition of "Shipley and MacBride" will receive a welcome from students and teachers of zoology, for the original work—published in 1901—took at once a distinct place among text-books on account of the freshness and individuality of the authors' method. The present volume exceeds in length its forerunner by 100 pages, and many improvements have been introduced. For example, the groups of the flatworms, nemertines, rotifers, and nematodes have been brought from their former position at the end of the volume following after the mammalia, and placed before the annelida. The arrangement, which startled readers of the first and second editions, was intended to emphasise the authors' opinion that these groups are not cœlomata, and this opinion is still set forth, perhaps too dogmatically, in the clear "Introduction to the Cœlomata" that precedes immediately the account of the annelids. The authors have accepted Goodrich's distinction—now familiar to zoologists—between true nephridia and cœlomoducts (such as the excretory tubes of arthropods, molluscs, and vertebrates). They also revert to the "orthodox" interpretation of the mammalian ear-ossicles, and in connection with this problem supply a valuable diagram of the temporal region of the skull in theromorphous reptiles for comparison with the mammalia. The book still neglects, to a great extent, palæontological as well as embryological facts, but these are invoked where questions of morphology and relationship are discussed. Indeed, the last half of the volume comprises an excellent introduction to the comparative anatomy of vertebrates. As regards systems of classification, there is always room for differences of opinion, but we believe that most students of the Mollusca will object to the removal of the Chitons from association with Chætoderma and Neomenia, and their replacement in the Gastropoda; while among the arthropods, the unnatural group of the "Myriapoda" is still retained, and appears in the same class with the insects and the peripatids—an altogether indefensible association. The introduction has been lengthened by two pages for the inclusion of a necessarily imperfect sketch of recent work on heredity.

(2) Indeed the writers of comprehensive modern text-books must be constantly faced with the question whether it is better to discuss some subject imperfectly or to leave it alone altogether. Profs. Kellogg and Doane have, with considerable success, attempted, within the limits of a handy volume, to furnish their students with a guide not only to the facts and principles of zoology but to its applications to hygiene, fisheries, agriculture, horticulture, forestry, and stock-raising. What may be called the general zoological sections of the book are often sketchy—as where the development of the Mammalia is dismissed in less than a page and the student is told that there is no placenta in marsupials. But there is much trustworthy information pleasantly given, the examples being drawn mostly from North American species. The concluding portion of the book is devoted to economic subjects, and there may be found accounts—good though brief—of harmful protozoa, insects, and arachnids, with the means to be adopted for repelling their attacks. The authors might perhaps have used the space at their disposal more effectively by expanding this section to fill the whole volume, leaving the student to get his general facts from existing books, of which there are surely enough. Yet a chapter of twelve pages on "Animal Life and Evolution" is a wonderful example of what can be done in the way of packing a surprising number of valuable facts and suggestions into a small compass. It might indeed be defined as a sample of "compressed biology." G. H. C.

ECONOMIC GEOGRAPHY.

An Atlas of Economic Geography. By Dr. J. G. Bartholomew. With introduction by Prof. L. W. Lyde. Pp. lxvi+96 maps. (London: Oxford University Press, 1914.) Price 5*s*. net.

THE name of Bartholomew on any atlas is a synonym for careful draughtsmanship and artistic colouring, and the "Atlas of Economic Geography" is not only no exception to the rule, but also a marvel of cheapness. Prof. Lyde as joint-editor is responsible for the selection of the maps, which are intended to illustrate mainly world and continental distributions. So far as they go, the various maps and diagrams make up a valuable collection. The generalisation necessary for such small-scale maps has been on the whole successful, except in the case of gold, the colour for which is much too liberally distributed. No attempt has been made, however, to distinguish on the map of Europe between major and minor industrial areas, and the absence of large-scale economic maps of the countries of Europe distinctly handicaps the atlas for purposes of advanced study.

Prof. Lyde has also contributed an introduction, which contains a large amount of both information and speculation. The prefixing of a lengthy and highly didactic introduction to an atlas intended for general university use is a somewhat new departure from well-established precedent. The presence of such an introduction tends to embarrass the teacher, who in this case may possibly differ from Prof. Lyde both in matters of opinion and in methods of teaching. A brief description of the plates of an atlas may at times be useful, but the proper place for all controversial matter is in an accompanying handbook which need not necessarily be placed by the teacher in the hands of his students. An atlas should be concerned solely with facts, to the ultimate arbitrament of which a teacher may refer all matters of opinion.

There are two methods of teaching economic geography as a university subject. One is to make certain general statements, and then to proceed to illustrate them by reference to the distribution of certain commodities and industries. The other is to begin with the distribution, and after due consideration of all the facts to attempt a theoretical explanation. Since many of the so-called principles of economic and anthropo-geography are by no means demonstrated, the latter method would at present appear to be preferable. Prof. Lyde, however, evidently believes that better results may be obtained from the former. Hence his introduction abounds in picturesque and suggestive ideas which the student is encouraged to believe may be verified by a careful examination of the facts of production and distribution. For example, it is stated that the ideal climate for wheat is of the Mediterranean type, while as a matter of fact the maximum yield per acre, which, in the absence of any other universal criterion, may fairly be taken as an indication of climatic suitability, is found in a region the climate of which is not usually classified as Mediterranean.

Again, the climatic control of the distribution of textile industries, emphasised in the introduction, has long been one of the pious beliefs of economic geographers. It has now become customary to limit the application of this so-called principle to the manufacture of only the finest goods, but the necessity of introducing such a limitation should be sufficient to put teachers on their guard against making any categorical statement upon the subject. To state in advance and with authority the conclusion which should be drawn from a study of certain regional and economic facts is an insidious method of giving what may be an unfortunate bias to the undeveloped mind.

J. D. F.

SEWAGE PROBLEMS.

Sewage Purification and Disposal. By G. B. Kershaw. Pp. x+340. (Cambridge: At the University Press, 1915.) Price 12*s*. net.

THOSE who accept the conclusion of the author that "Sewage purification is the outcome of the activities of bacteria mainly, but assisted by chemical and physical actions, and the purifying agencies of various algæ and water plants," will probably consider that only in a limited degree does this book fulfil the claim of the editors of the series to present the latest scientific and practical information upon the subject with which it deals.

Consideration of the biological aspect of the problem is comparatively brief and superficial, and the author is of opinion that "It does not come within the province of this book to touch more than briefly upon chemical points." The outlook is that of an engineer, with extensive rather than intensive experience of the problem; the treatment descriptive and intelligently empirical rather than scientific, but within these limits the book is an informative account of present-day practice.

The difficulties, both quantitative and qualitative, of the sludge problem are kept well before the reader's attention, and it is realised that circumstances may justify the discharge of appreciable quantities of suspended matter on to suitably designed filters, with the view of effecting the separation of a large proportion of the inevitable solid matter in its least objectionable form. The entire failure to recognise the significance of the Dibdin slate bed, in this connection, is somewhat remarkable.

Probably the most useful sections of the book are those dealing with conservancy systems, and with land treatment, in both of which a clear conception of actualities is presented.

The references to foreign practice constitute a valuable feature, and in certain sections, as, for instance, those dealing with the influence of tank velocity upon the character of the deposit, either of detritus or of the main bulk of sludge, might with advantage have been extended, since English practice, as interpreted by the author (in dealing with the construction of detritus tanks, for example, "from 1/100th to 1/200th part of the total dry weather flow of sewage is, perhaps, a usual capacity provided"), affords such uncertain guidance upon important details of works design.

Neither practical nor scientific value can be attached to Table XV, "Showing the dimensions of several septic tanks in use in England," or to the bald statement that circular tanks of the Dortmund type are in use, as septic tanks, in the absence of comment as to the suitability of the design to the object in view. The comparison between contact and percolating filters is carefully, and on the whole fairly, drawn, although it is not quite clear whether the working costs quoted are strictly comparable.

Assumption of the colloidal form is so characteristic a property of fæcal matter that the author's belief that the colloidal matter of sewage is derived in great measure from soap would seem to require some definite experimental support or reconsideration.

The book is well indexed, and is provided with a useful bibliography. PERCY GAUNT.

THE PRODUCTION OF NEW VARIETIES OF PLANTS.

Fundamentals of Plant-Breeding. By Dr. J. M. Coulter. Pp. xiv + 347. (New York: D. Appleton and Co., 1914.) Price 6*s.* net.

PROF. COULTER is entering the ranks of the writers of books on scientific subjects, as he already has a place amongst those who produce scientific books. In the volume before us he has certainly achieved a considerable measure of success in making difficult matters fairly easy of comprehension by any ordinarily intelligent person. The carping critic may perhaps object that the dose of science is sometimes contained in too abundant a vehicle of padding, but at least he will scarcely allege that the padding itself is totally devoid of flavour.

The author has skimmed over many difficult and debatable matters with a freshness and vigour of expression which makes his book a pleasant one to read, and he has contrived to weave into the text a very considerable amount of theory and fact. Even those who are tolerably familiar with the work of plant breeding will probably find much that is of interest in what we might perhaps describe as the more remotely relevant matter. The book is, of course, written from the American viewpoint, but it is good that people in this country should have brought forcibly to their notice the supremely important problems that underlie so much of scientific agriculture, in which an immense amount of capital is invested. The Americans take these problems seriously, and the people are interested in the results which mean so much to the country, for it is from the soil and its living products that the permanent sources of wealth of a community must, after all, largely depend.

Prof. Coulter deals with the various methods of raising new and valuable plants, of conserving what has been obtained by the application of rational, and therefore truly scientific, principles which enable disease to be successfully fought, and by which further improvements are to be secured. He also deals with the more outlying topics of forestry, the soil, search for new plants, the work of experimental stations, and so on, and he may be congratulated on the production of an interesting, instructive, and readable volume.

We note a few points in connection with which a future edition will, perhaps, afford an occasion for modification. The lettering of the figures on p. 11 is omitted; and surely Figs. 15 and 16 should not be quoted from the text-book of which Prof. Coulter is joint-author, but from the original source, *i.e.* from Bonnier's admirable paper on the effects of habitat on plant structure. Exception might well be taken to the illustration on p. 5 of fluctuating and constant variation, on the ground that the potato tubers quoted are the result of vegetative, and not of sexual, reproduction, and the illustration itself also strikes one as having an air of unreality about it. A serious misapprehension of Weismann's position would probably be gathered by the uninstructed reader of p. 68, on which it is briefly stated that "Weismann thought that all the characters of both parents are represented by ids in the fertilised egg. This was the necessary antecedent to 'amphimixis.' Mendel, on the other hand, showed that characters are segregated in the reproductive cells." Weismann would certainly have repudiated the justice of the contrast in this form. But, despite slips such as these, the book is a good one.

OUR BOOKSHELF.

The Earth: Its Life and Death. By Prof A. Berget. Translated by E. W. Barlow. Pp. xi + 371. (New York and London: G. P. Putnam's Sons, 1915.) Price 7*s.* 6*d.* net.

PROF. BERGET has written in popular terms a physical history of the earth. He has endeavoured to discern the mode of its origin and to estimate its age, to describe the phenomena of the present living globe, and finally to forecast the manner of its death. He has certainly succeeded in rendering many difficult lines of reasoning clear and intelligible to the general reader. The book is in no part dull, and would not read like a translation were it not that English equivalents are added after all measurements in metres or in centigrade degrees. Besides the translator's interpolations, an unnamed editor has inserted in the text many notes which would have appeared more appropriately at the foot of the page. As these notes are on astronomical points only, they leave the impression that other subjects stand in similar need of amendment, and there can be no doubt that this is the case in more than one chapter.

Sometimes the author writes with a little too much confidence. He treats a theory almost as if it were a scientific fact. For instance, he refers to the contraction theory of mountain-formation as though its foundation were secure. He accepts as proven an eleven-year period of earthquake-frequency and the increased frequency of earthquakes at the times of the equinoxes.

While reading the book, it is difficult to resist the impression that the author does not always trust to original authorities. This impression is perhaps strongest in the chapter on seismic phenomena, in which, though the original text must have been written in or after 1909 (see p. 208), many facts are omitted which should have found a place. Indeed, in this chapter of thirty-eight pages, the name and work of Milne are never once mentioned.

A Map of the Western War Area. Edited by Prof. A. J. Herbertson. 60 in. × 60 in. (Oxford: The Clarendon Press.) Price, mounted in sections, with names 15*s*., without names 12*s*. 6*d*.

THIS useful and striking map depicts the country from the Seine to the Rhine, and from the Swiss frontier to the Rhine delta, on a scale of eight miles to 1 in. (1 : 500,000). It is provided with contour lines and layered colouring, and shows vividly the interdependence of land relief and military strategy. It is issued in several forms—unmounted, mounted in sections, and mounted on rollers, varnished or unvarnished, at prices varying from 10*s*. 6*d*. to 17*s*. 6*d*. Produced under the supervision of Prof. Herbertson, it provides an excellent and trustworthy companion for the student of current events in France.

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.*]

A Canadian Memorial to Hugh Miller.

IN a letter which I have just received from Dr. John M. Clarke, director of the State Museum at Albany, N.Y., he writes:—"You may be interested to know that at my urgent suggestion the Geographic Board of the Province of Quebec have adopted the name 'Hugh Miller Cliffs' for the wonderful Old Red Sandstone fish-beds which line Scaumenac Bay on the Bay Chaleur, near the Gulf of St. Lawrence. I think there is no place in the world where the fishes Hugh Miller described are so abundant. It is a little odd that the devout French Catholics of P. Quebec should consent to this naming of their scenery after a Scotch Presbyterian, but the cliffs look across the bay from French Quebec to Scotch New Brunswick!"

Geologists in this country will be pleased to hear of this Transatlantic recognition of Miller's pioneer work, and they will feel that Dr. Clarke, who is familiar with the classic Cromarty ground, as well as with that of Scaumenac Bay, deserves our thanks for suggesting this unusual but most appropriate memorial, and for his successful efforts to have it carried out.

ARCH. GEIKIE.

Shepherds' Down, Haslemere, June 24.

The "Green Fluorescence" of X-Ray Tubes.

THE Glass Research Committee of the Institute of Chemistry has recently issued a note on the conditions for obtaining green fluorescence under kathode rays in glass suitable for X-ray tubes indicating that the presence of a small amount of manganese must be present. In view of the fact that there appears to be some misconception regarding the necessity of the green fluorescence it may be of interest to give a brief account of what is involved in obtaining as marked a fluorescence as that which has usually been noticed in working X-ray tubes hitherto.

So far as I am aware the advantage of the green fluorescence is that it provides the X-ray operator with a convenient rough indication of the "hardness" of the tube. It is scarcely necessary to point out that the quality of the X-rays is in no way influenced by the nature of the fluorescence of the glass. Experiment has shown that a strong green fluorescence can only be obtained at some sacrifice of the excellence of the glass. Glass manufacturers frequently add manganese dioxide to a glass mixture to correct the green colour due to iron which is invariably present to some extent in the ingredients used, and, of course, the more iron there is as an impurity the more must be the amount of manganese dioxide added. Thus in some cases, in order to obtain the full green fluorescence, an appreciable quantity of iron must be added to relatively pure ingredients so that the necessary quantity of manganese may be incorporated in the glass, the iron being needed to correct the amethyst colour which so much manganese would otherwise impart to the glass.

This procedure appears to impair the working qualities of the glass to some extent, and it is found that glass of a quality superior (in respect to its behaviour in the flame) to that usually employed can be made if iron and manganese are avoided. A few experiments may be mentioned in support of this statement.

Glass made from pure materials shows practically no fluorescence, the feeble glow being of a grey-blue colour. A Rupert's drop made from the same glass gives a similar feeble glow.

A Rupert's drop made from glass giving normally a strong green fluorescence shows only a slight grey-blue glow. After the tail of the drop had been heated to softening point this part showed the usual green glow. In a high vacuum under very intense bombardment there was an indication of some slight green glow on the drop. The drop was broken and the powdered glass gave the full green glow. The evidence was that only a very thin skin represented the part cooled quickly enough to give next to no fluorescence.

Calcium silicates of varying composition containing a little manganese, which were fused by the oxy-hydrogen blowpipe, showed on the outside portions, which appeared to be completely vitreous, no fluorescence at all, while the inside which had cooled more slowly, and was found to be crystalline, gave a very brilliant green glow.

Calcium metaborate can by very sudden cooling be obtained in a vitreous state showing no fluorescence, while the crystalline variety gives a moderate blue glow. The presence of manganese induces no fluorescence in the vitreous form, but a very brilliant green in the crystalline modification. Evidence has been obtained that many substances which, in their crystalline form, fluoresce brightly, exhibit no glow in the amorphous or vitreous state.

From numerous experiments it is concluded that the green fluorescence of X-ray tubes is associated with the presence of a notable quantity of calcium and a relatively small amount of manganese, that a truly vitreous glass exhibits little, if any, fluorescence, and that a glass containing manganese can only be kept in this condition by extremely sudden cooling.

Without suggesting that ordinary X-ray glass has any definitely crystalline structure, the evidence would indicate that something akin to this is more readily obtained when manganese is present.

A tendency to crystallisation may be so slight in a glass as not to interfere with its use under ordinary working conditions, but there is no advantage in fostering this tendency. The presence of manganese in any appreciable amount introduces other defects of minor importance. I mention them only to emphasise the point made before, that if the intensity of green fluorescence seen in many foreign X-ray tubes is considered imperative it can only be obtained by sacrificing some of the good working qualities of the new and purer English glass.

HERBERT JACKSON.

University of London, King's College, June 23.

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

THE magnetic storm described in NATURE of June 24 by the Rev. A. L. Cortie seems to have been larger at Stonyhurst than at Kew. The extreme westerly position of the declination needle at Kew occurred about 1.30 p.m., and the extreme easterly position about 5.37 p.m., the total range being about 72′. Between 5 and 6 p.m. the movements had a range of 61′. I am not clear which of the two corresponds to the 91·5′ mentioned by Father Cortie, but either is substantially less, even allowing for the fact that the strength of the horizontal field is about 6 per cent. higher at Kew than at Stonyhurst. This is, of course, quite in accordance with the usual tendency for disturbance to be greater in higher latitudes, but it helps to illustrate the fact that whatever the ultimate source may be, terrestrial position counts for a good deal. The total range shown by the horizontal force at Kew was about 460γ ($1\gamma \equiv 1 \times 10^{-5}$ C.G.S.), the maximum occurring about 5.42 p.m., and the minimum about 9.30 a.m.

Father Cortie's remarks on the absence of the rapid oscillations sometimes characteristic of magnetic storms refer, I presume, to the time 4 to 6 p.m., when the largest movements occurred. Earlier in the day, for instance, near 6 a.m., the oscillatory character was fairly prominent at Kew. One would, in fact, have expected to hear of telegraphic interruptions.

Father Cortie seems to associate the magnetic storm with a particular spot or group of spots on the sun. That at least is what one would naturally infer from his remark: "Such a close approximation of the position of the spot and the earth referred to the sun's central meridian during a magnetic storm is very unusual." Whether magnetic storms are directly due to the emission of electrons from the sun, and, if so, whether the emission is localised in sun-spots, are questions on which there is a diversity of opinion. The present case seems a good example of the difficulties in the way of a final decision. Father Cortie tells us that "on June 17–18 there were no fewer than seven groups of spots visible." On the other hand, the disturbance of June 17, though much the largest, was by no means the only magnetic disturbance about the time. There was, as Father Cortie mentions, what is usually termed a "sudden commencement" about 1.50 a.m.—I make it a minute or two later—on June 17, but there was another—somewhat larger—about 1 p.m. on June 16. The subsequent disturbance on June 16 was not large, and after 6 p.m. the conditions were fairly normal. We should naturally regard the disturbances on June 16 and 17 as distinct. Then on June 21, about 3.10 p.m., there was yet another "sudden commencement," the largest of the three, and this was followed by a considerable disturbance lasting to the end of June 22. "Sudden commencements," even when small, are usually recognisable over at least the greater part of the world. Of all types of disturbance they seem to have the best claim to a cosmic origin. The subsequent disturbances, when there are any worth mentioning—which is not always the case—show much more rapid local variation.

We have here, then, three disturbances with sudden commencements in the course of about five days, so that even accepting the sun-spot emission theory, in the absence of special identification marks, the association of one particular disturbance with one particular spot or group of spots would seem to be arbitrary.

Another aspect of the case is that magnetic disturbances sometimes occur when sun-spots are conspicuously few or wholly absent. For instance, there was a "sudden commencement" of considerable size on June 7, at a time when Father Cortie tells us the sun was almost free of spots.

The fact that magnetic disturbances occur at intervals of from twenty-six to twenty-eight days more frequently than is accountable for by pure chance is obviously consistent with the sun-spot emission theory; but it does not necessarily favour it. Quiet magnetic conditions show the "twenty-seven-day" period to practically the same extent as disturbed conditions. Sometimes disturbance is the rule, and quiet conditions the exception, and it is not clear that the one phenomenon is more fundamental than the other. There seems a difficulty in associating quiet conditions with some limited area, some "anti-spot," on the sun.

C. CHREE.

June 26.

The Names of Physical Units.

MAY I point out that Dr. Guillaume is wrong in suggesting, in his letter in NATURE of June 17, that the adjective "specific," employed in connection with physical magnitudes, has no constant and definite meaning? "Specific" is the adjective of "species," and the "specific resistance of iron" is that function of the resistance of a piece of iron and the other physical magnitudes characteristic of the piece which is the same for all pieces which belong to the species "iron." The statement made in the last sentence is true if for "resistance" be substituted any other magnitude to which "specific" is attached, and for "iron" any other form of matter which is recognised as a "species."

I am not urging that the retention of the term "specific" is desirable; on that matter I offer no opinion. I am only urging that the word has a perfectly definite and constant meaning.

Teddington, June 22. NORMAN R. CAMPBELL.

THE USE OF COTTON FOR THE PRODUCTION OF EXPLOSIVES.

THE history of the laboratory production of various forms of nitro-cellulose has been well stated by many chemists, and everything essential can be found either in their own researches or in the ordinary text-books. The practical outcome of such work has been the establishment of modes of manufacture for many purposes, but in the present instance it is proposed to deal entirely with the use of cellulose in one shape or another for explosives of any practicable kind. It is almost unnecessary to state here that every kind of propulsive explosive now used has cellulose as its basis, but it may not be superfluous to say that all military propulsive explosives have cotton for their basis as distinct from cellulose.

The word cellulose must not be understood in the strict chemical sense, but rather as including all those materials which are chiefly cellulose, and this definition will include materials like wood-pulp. Now one may clear the ground on this subject at once by saying that, for military purposes, wood-pulp and other impure forms of cellulose are useless. Very good sporting powder can be made from nitrated wood-pulp, but the artillerist would be in great difficulty if he were provided with such a propellant, because in order to obtain any sort of regularity the nitration of the wood-pulp has to be kept at a low point, and the ballistics on which the artillerist depends would be quite thrown out. The modern gun is really a machine of precision; the artillerist knows that and expects it to throw one shot after another to reach the same point within a fraction of its possible range as computed from its elevation of sighting, and his whole attention has been based on this. If he were supplied with a material, however good, which on explosion developed a lower pressure, he would be relatively helpless and his rivals, using their own standard material, would have him at a sore disadvantage.

In modern practice, the raw material used is cotton waste, which is, as its name implies, merely the rejected stuff in the manufacture of cotton goods; and although linters, which is the technical term for the short fibre material adhering to the cotton seed, may be used, yet its employment presents serious difficulties in that the seed with which it is associated has to be removed by chemical treatment. There have been many experiments made to use such substances as jute, ramie, kapok fibre, and in short everything from sulphite pulp to spun cotton, but as workable substances these have been rejected in favour of the staple material—cotton waste.

The method of producing a satisfactory form of nitro-cellulose from cotton waste is as follows:—The waste is hand-picked so as to remove the grosser impurities. The product is teased, picked once more, and then dried. After that, the nitration process is carried out, and this has been much modified in the light of experience, but in essence still consists in the immersion of the purified waste in a mixture of nitric and sulphuric acids of the following composition: H_2SO_4, 71 per cent.; HNO_3, 21 per cent.; H_2O, 8 per cent. The amount of water in this mixture is important, and the acids as they are written are as their formulæ represent and do not refer to the commercial products. The strict relationship of the water to the two active materials should be preserved. It is of course easy now to obtain sulphuric anhydride (SO_3) and make an anhydrous mixture, but this gives a nitro-cellulose with too high a nitrogen content. After the mixed acids have acted for the required time, they are removed and the gun-cotton is washed to remove as much of the acid as possible, and purified by several boilings with water. The boiling with water is of great importance, as in this part of the process the unstable bodies produced during nitration are dissolved or decomposed, leaving the nitro-cellulose in a stable condition. The only thing now remaining is to pulp the cotton, which is again washed and then partly dried and moulded into the required shape by pressure.

The old idea that something as nearly as possible to the so-called hexa-nitrate of cellulose should be aimed at has been fairly well exploded, and the manufacturer seeks to regularise his output so that he may obtain a nitro-cellulose with approximately 11 molecules of NO_3 to the quadruple molecule, as shown in the formula $C_{24}H_{29}O_9(NO_3)_{11}$. This formula must not, however, be taken as any more than a convenient way of expressing the degree of nitration, which is really better stated in terms of content of nitrogen which ranges between 12·93 and 13·05. This is merely a parenthesis, but is necessary as showing how delicate and complicated a matter it is to obtain a uniform and trustworthy material for propulsive explosives, and as it has been found in practice that even what is apparently such a simple matter as the preparation of a mixture of acids of known composition is really one requiring some care and skill. It will be readily understood that the difficulty is trifling compared with that of providing an equally regular form of cellulose. So well is this recognised that different consignments of cotton waste, all of approved quality, all picked, teased and re-picked, are mixed so that the cellulosic raw material may be as nearly the same grade as possible.

With this fact in front of us, let us consider what the condition of a factory would be which had to use any kind of raw material, clean or dirty, lignified or not, and had to try to make that into a trustworthy propulsive explosive of standard quality. This question has only to be asked for the answer to provide itself. In the present case a great deal too much has been assumed as to the capability of our enemies for making trustworthy nitro-cellulose without cotton waste. Because any competent chemist in his laboratory could make some form of nitro-cellulose from his own shirt cuffs if he pleases, people have jumped to the conclusion that that will be of some use to the artillerist. The fact that the manufacturing process of an explosive like this is of the most delicate kind and has to be conducted with military precision, has been constantly overlooked; and at the present moment it is not too much to say that there is only one material available for modern gunnery, and that is cotton.

PROBLEMS OF AIRSHIP DESIGN AND CONSTRUCTION.

THE problem of the airship falls naturally into three parts, concerned with flotation, propulsion and steering respectively. The best results in any of these three branches are to a great extent antagonistic to similar success in one or both of the other two. For instance, flotation, which is purely a displacement problem at bottom, demands that the displacement body should have the greatest volume for the least superficies, *i.e.*, that it should be spherical. Propulsion, on the other hand, demands that the body be of the shape having least head-resistance, *i.e.*, of long fish-shape. Steering, with which is linked dynamic stability, demands that large fins and control surfaces be affixed to the body, which otherwise would set itself broadside on to the relative current caused by its forward movement. These auxiliary surfaces add to the weight, that is, oppose flotation and add to the head-resistance, thus opposing propulsion. Again, the displacement body must of necessity consist mainly of a gas lighter than air. All the light gases are highly inflammable (or if not have some other disadvantage), and consequently are dangerous in proximity to an internal-combustion motor, such as is universally used for propulsion, as being the only motor with a good ratio of power to weight. Therefore the motor must not be placed too close to the gas-container, and in consequence it is difficult to enclose all the parts of the airship in a single "streamline" body of least resistance, and the head-resistance and weight are thus both increased considerably, opposing propulsion and flotation.

The above list of incompatibilities might be extended considerably, as every airship designer knows to his cost. It is not to be wondered at, therefore, that airship design is in so fluid and embryo a condition that the future of the airship is looked upon as extremely dubious in many quarters. The fact, however, that so much progress has been made in face of stupendous difficulties is a happy augury for the future of the airship, especially as many of the difficulties met with are due mainly to the fact that airships are at present small, and they will disappear as soon as experience and growing confidence enable large and larger vessels to be built.

To deal with the displacement body, or lifting unit, first. The lift obtainable is, of course, directly proportional to the weight of air displaced and inversely proportional to the weight of the displacement body in itself. Roughly, thirteen cubic feet of air at sea-level and normal temperature weigh one pound, so that a lifting unit displacing that volume would lift one pound minus its own weight. Consequently, if the lifting unit consisted of "nothing shut up in a box" as the schoolboy's definition of a vacuum runs, only the weight of the box would have to be deducted from the gross lift obtainable. As no light vacuum-container could maintain its shape against atmospheric pressure, however, a gas must be used to keep the displacement body distended by its expansive properties. The gas universally used for airships is hydrogen. This weighs about one-fifteenth of unit volume of air, so that only 1/15 gross lift is lost by its use. The possibilities of getting wonderfully enhanced lift by new gases, lighter than hydrogen, are thus seen to be illusory.

Coal gas was long used (and still is) for ordinary spherical balloons, as being cheaper and more available than hydrogen, but being about ten times as heavy as hydrogen, is comparatively useless for airships. Ammonia vapour has been suggested for airships, as being non-inflammable, but is about eight times as heavy as hydrogen and of a destructive character to metal, etc. The provision of a stable non-inflammable light gaseous mixture would solve so many practical difficulties in the construction of airships that many thousands of pounds could profitably be expended in research on this problem. Failing this provision, all precautions must be taken to prevent fire, or to minimise its effects on board airships.

Hydrogen being non-explosive apart from oxygen, can be isolated in containers jacketed with an inert gas and thus rendered harmless. The division of the displacement body of an airship into compartments is desirable from this and other points of view. For example, a large volume of gas in a thin fabric container is prone to surge about and strain the container when in motion. Compartments prevent this and also localise leakage due to rupture of any part of the container.

The type of airship in which this principle is carried farthest is the rigid type (Zeppelin) in which the displacement body consists of seventeen or eighteen separate gas-containers, set in a rigid cylindrical framework, like peas in a pod. The chief advantages of the rigid framework are (i) that the actual gas-containers are relieved of strain and are (ii) protected from the influence of weather. The disadvantages are (i) the loss of gross lift due to the weight of the framework, and (ii) the fact that the airship cannot be folded up for transport or storage, and must consequently be housed in a large and expensive shed.

The gross lift of a large Zeppelin is about twenty-five tons, of which about twenty tons are absorbed by the framework, engines, etc. This gives a net lift of only about one-fifth of the gross lift, a figure that could be much improved upon by making the vessel larger. This net lift has to account for crew, etc., so that not more than two tons of explosives could be carried, and this only at a low altitude. Naturally, other things being equal, the weight of the framework, etc., of a small airship is a larger proportion of the gross lift than the corresponding weight of a large airship.

In that type of airship in which the walls of the gas-container are themselves the "framework" of the displacement body (the "non-rigid" type), much weight is saved, but disadvantages come in that strains on the fabric affect its gas-tightness, which is also much affected by action of sun and other influences.

Again, the attachment of the car (containing the engines, etc.) by wire ropes to the container is worked out on the assumption that the gas-container will retain its shape. This end is attained in single gas-containers by having a bag of air (the "ballonet") inside the container, into which is pumped air under pressure, to maintain the full volume and shape of the envelope. If, however, compartments are to be used in the container, some means of equalising their pressures even if one be ruptured must be devised, otherwise the shape will be distorted. This is no easy task.

The non-rigid type has the great advantage of being quickly deflatable for transport packed up. Examples of this type are the Parseval and Astra-Torres, in which latter ship an ingenious system of suspension greatly strengthens the gas-container.

The "semi-rigid" type has some of the advantages and the disadvantages of both the other types. Examples are the Forlanini (Italian) and Astra XIII. (Russian).

The material of which gas-containers are usually constructed is made of layers of cotton fabric cemented to layers of rubber. In order to intercept the blue (actinic) rays of light that "rot" the rubber very quickly and make it porous to the gas, the fabric is coloured yellow. Gold-beater's skin makes a very gas-tight container, but untreated is affected by rain, which is absorbed, and by its weight decreases the net lift. This disadvantage applies to untreated fabrics, which are therefore usually varnished with an aluminium varnish, thus preventing water absorption and promoting gas-tightness. Fabric impregnated with gelatine, rendered flexible by added glycerine, and insoluble by formaldehyde, has given promising results. Oiled silk is very gas-tight but seams are troublesome. Very much research is still required into the question of fabrics.

Propulsion demands a power plant and means for obtaining a reaction from the air. The ratio of power installed to weight lifted has been steadily rising both in airships and aeroplanes. The first Zeppelin airship (1900) weighed 10,200 kilograms and the motors were two, totalling 32 horse-power. Zeppelin III. (1906) lifted 12,575 kg., and the motors (2) totalled 130 effective h.p. The "L1" (marine) of 1913 lifted about 28,000 kg., and the motors totalled 720 h.p. As an indication of the performances that may be expected from airships in years to come, we may note the proportion of power to weight lifted in the last vessel as one horse-power to every 80 lb. lifted. The speed attained is fifty miles an hour. In the case of an aeroplane doing ninety miles an hour or so, the weight lifted is only about 15 lb. per horse-power.

Screw propellers are universally used for airships, and are often of wood. They are usually placed at the sides of the gas-container in rigid vessels and below it in non-rigid vessels. Much research is needed as to the best position for propellers relatively to the body to which they are attached.

A strong reason for increasing the power of airships is that by so doing a large amount of lift can be obtained by the dynamic action of the large control surfaces, which, by directing the airship's nose up, are able to give it a very fast rate of rise, much quicker than that of aeroplanes.

The maximum height attained by airships is somewhat more than 10,000 feet (Zeppelin and Italian). Aeroplanes have ascended twice as high and ordinary balloons three times as high. To attain 10,000 feet high an airship must sacrifice much ballast and gas, so that it cannot voyage for its longest period at a great height. Zeppelins are claimed to be capable of holding the air for three days, but not at full speed or height. There is no advantage in going very high (except for military reasons), and under 3000 feet would be a usual zone in which to operate were it not for anti-aircraft measures. Some day, when the airship is better developed, it may pay to go to great heights in order to obtain the advantage of lessened resistance to advancement due to the tenuity of the air.

As regards steering and stability, it may be said at once that most airships steer clumsily and require large spaces in which to manœuvre. Our little non-rigid vessels have been specially developed for handiness in our much wooded country, but Zeppelins are craft for vast open spaces. The dynamic stability of an airship is a complicated matter to work out. Besides ordinary pitching and rolling there are added effects due to surging of the gas and distortion of the gas-container. Propellers also complicate the stability question. Large control surfaces are essential, sticking well out from the body, to avoid its "wash."

A REGIONAL SURVEY.[1]

A MODERN element in the fascination that islands undoubtedly exert is their biological interest. What are the island's inhabitants of high and low degree? How came they there and whence? How has the isolation affected them?

[1] "A Biological Survey of Clare Island in the County of Mayo, Ireland, and of the Adjoining District." Section I. (comprising Parts 1 to 16), Introduction, Archæology, Irish Names, Agriculture, Climatology, Geology, Botany. Section II. (comprising Parts 17 to 47). Zoology (Vertebrata, Mollusca, Arthropoda, Polychæta). Section III. (comprising Parts 48 to 68), Zoology (Oligochæta to Protozoa), Marine Ecology, Summary. (Dublin: Hodges, Figgis, and Co., Ltd.; London: Williams and Norgate, 1911–15.)

Such are the biological questions which, as Mr. Lloyd Praeger remarks, have led many naturalists to study islands. He recalls Alphonse de Candolle, Edward Forbes, Charles Darwin, Alfred Russel Wallace, and Sir J. D. Hooker; and many other names might be cited. The same old questions led a number of naturalists in 1909 to plan and inaugurate the survey of Clare Island, which has now been completed to the great credit of all concerned. The island was chosen because of its suitable size and position, because of its unusual elevation as compared with most of the islands lying off the west coast of Ireland, and for various practical reasons.

Clare Island lies across the entrance to Clew Bay, at about the middle of the great projecting buttress of ancient rocks which forms west Galway and west Mayo. It is almost cliff-bound, the cliffs varying from 50–100 ft. in the east and south to 1000 ft. in the north-west. The dominating feature is the high ridge of Croaghmore (1520 ft.) on the north-western shore. "On the inland (southern) side Croaghmore presents a steep heathery slope, and on the seaward face plunges down a magnificent precipice into the Atlantic." Its scarp is the home of a very interesting Alpine flora, and affords a sanctuary of wildness to many animals which could not survive the close grazing of other parts of the island. The adjoining islands of Inishturk and Inishbofin, which are included in the survey, are in a general way similar to Clare Island, but with no such lofty elevations.

The survey had two main objects in view:—(1) The study of the fauna and flora of this extreme verge of the European continent, and (2) the study of an insular area with reference to the special problems of island life and of the dispersal of organisms. As regards the first object, the results have far exceeded expectations, but as regards the second there was some disappointment.

A geological study of the area showed that it was not only probable, but almost certain, that a land-connection between the island and the mainland existed long after the Glacial period, which would have permitted of the immigration of much of the present fauna and flora after normal climatic conditions were resumed.

In short, the investigators soon found that they had to do with an assemblage of animals and plants that had *not* crossed even a few miles of sea.

As regards the fauna and flora in general, excluding winged animals and spore-plants, there is practical unanimity of opinion, resting on varied evidence from many different groups, that the narrow strait of sea which separates Clare Island from the mainland represents a very serious barrier to migration, and one across which the existing fauna and flora of the island, taken as a whole, could not have passed.

If the study of Clare Island as an island was rather negative, the other aim of the survey was realised in a manner positive enough to delight everyone, and some indication must be given of the number of additions made to the fauna and flora of Ireland and of the British Isles, and of the number of species discovered which were new to science. No fewer than 3219 plants were recorded, of which 585 were new to Ireland, fifty-five new to the British Isles, and eleven new to science. No fewer than 5269 animals were recorded, of which 1253 were new to Ireland, 343 new to the British Isles, and 109 new to science. This is a very gratifying result, and shows how many new forms of life still lie to be discovered not very far from our doors. It is pleasant to read that "almost the whole survey was carried out by volunteers, whose field-work had to be done in their own time, and, to a great extent, with their own money."

Photo.] [*R. Welch.*

FIG. 1.—Signal Tower Head, Clare Island. Silurian cliffs, 700 ft. high. Looking north. From "Clare Island Survey."

There are sixty-eight reports altogether, so that it would take considerable space even to mention subjects and authors. We are tempted to remark on the Foraminifera dealt with by Messrs. Heron-Allen and Earland (recording 287 species, thirteen new); on the Rhizopods by Messrs. Wailes and Penard (recording 129 species, five new); on the Flagellates and Ciliates dealt with by Mr. Dunkerly (recording ninety-eight species, many of them very interesting forms); on the marine sponges described by Miss Stephens (sixty-five species, including the new and interesting *Leucandra cliarensis*, with dermal monaxon spicules visible to the naked eye and giving the sponge a characteristic silvery-white appearance; on the Turbellarians reported on by Mr. Southern (forty-five from the sea and five from fresh water); on the Polychætes tackled by the same energetic worker (249 species, sixteen new—by far the largest list as yet recorded from any limited area); on the new genus Grania discovered by Mr. Southern, the first Oligochæt found beyond low-water mark and occurring down as far as twenty-four fathoms; on the spiders recorded by Mr. Denis R. Pack-Beresford (108 species and ten Phalangids besides); on the fresh-water mites dealt with by Mr. Halbert (eighty species, four new)—but it is obvious that we must not continue. It is needless to pick and choose where all the workmanship is good. Some of the studies—notably on Marine Algæ, Phanerogams, Polychæts, and Foraminifera—are much more complete than others, and this, it should be noted, is in part due to the simple fact that some of the specialists were able to visit the island oftener than others. This readily intelligible inequality was, of course, to some extent counteracted by co-operation in collecting.

Photo.] [*G. P. Farran.*
FIG. 2.—Clare Island from E.N.E. Croaghmore in the centre. Lighthouse on extreme right. Harbour on extreme left. From "Clare Island Survey."

Looking into the novelties more analytically, we find fifteen new genera—one among Fungi, three among Mites, three among Chætopods, and eight among Nematodes. As to the last, it must be borne in mind that our knowledge of British free-living Nematodes has been of the scantiest, and we are not surprised that Mr. Southern should speak of one of the gatherings as furnishing "an apparently inexhaustible source of new and interesting species." It was among the Lower Invertebrates and Lower Cryptogams that the biggest hauls of new records and new species were obtained. Thus there were thirty-three water-bears recorded, all new to Ireland (for there had been no water-bear list before), eleven new to the British Isles, and five new to science. One of the most interesting results is the demonstration of the rich micro-fauna of the "Polygordius ground"—a sub-littoral habitat with gravel, sand, and broken shells lying in about twenty-five fathoms of water. It abounds in the primitive Annelid Polygordius, and yielded six new genera and twenty-eight new species of small fry.

We should like to have been able to refer to the discussion of marine ecology by Mr. Southern, to the admirable introduction, narrative, and summary by Mr. Lloyd Praeger, and to the reports on history and archæology, place names and family names, Gaelic names for plants and animals, agriculture, climate, geology, tree-growth (rather a negative quantity), and non-flowering plants; for this model regional survey has been as comprehensive in its scope as it has been thorough in its treatment. The survey has been completed in six years, which means hard work and loyal co-operation. We heartily congratulate those who have contributed to an achievement to be proud of, and most of all the secretary and editor, Mr. Lloyd Praeger.

PROF. BARNARD'S ASTRONOMICAL PHOTOGRAPHS.[1]

THE name of Barnard is not only familiar to all astronomers, but also very generally to those who have from time to time perused illustrated astronomical books. The photographic recording of celestial objects has been carried by him to a very high state of perfection, and thereby not only has his own fame and that of the Lick Observatory been considerably enhanced, but our knowledge of the visible and invisible universe has been greatly extended. Unfortunately, it is an extremely difficult matter to reproduce, with complete accuracy, such photographs as are obtained by the combination of a telescope and a photographic plate, for not only do delicate lights and shades become relatively altered, but other errors may and do creep in during the process of reproduction. Further, the attempt to secure such high accuracy in reproduction increases very considerably the cost of publication. It will be gathered, therefore, that the extreme fineness and beauty of the original pictures cannot necessarily be judged by plates that have so far been published.

It is a great pleasure now to record the fact that, by a generous response for financial aid and with the assistance of considerable skill in reproduction, Prof. Barnard has been able to publish a selection of the photographs he took during the years 1892 to 1895. The volume contains 129 plates reproduced by the collotype process, and

1 "Photographs of the Milky Way and of Comets, made with the Six-inch Willard Lens and Crocker Telescope during the Years 1892 to 1895." By E. E. Barnard, Astronomer in the Lick Observatory, University of California. Publications of the Lick Observatory, vol. xi., 1913.

while Prof. Barnard states that "the very great delay in the appearance of this volume of photographs can only be attributed to the writer's anxiety to secure the best possible reproductions of the original pictures," the excellence of the reproductions is the reward due to the delay in question.

In the introduction to the volume the author brings together some very interesting information, both instrumental and photographic, with regard to these pioneer days. Possibly for the first time a statement is made regarding the origin of the now famous 6-in. "Willard" lens, the lens so often coupled with Barnard's name in celestial photography. Willard, so far as the author could gather, was not a maker of lenses, but simply a photographic stock-dealer, whose name was stamped on lenses made by C. F. Usner in New York City. These large lenses were used for making portraits during the wet-plate period of photography, their large apertures being necessary to shorten the exposure during portrait sittings. Their application to astronomical work was first made by an amateur who used the above mentioned 6-in. "Willard" lens for photographing the solar corona during the eclipse in January 1, 1889, visible in Northern California. Some of the photographs taken were so excellent, and showed so well the great extent of the coronal streamers, that Prof. Holden, then director of the Lick Observatory, who was impressed with the excellent results obtained with it, purchased this lens for the observatory with funds provided by the Hon. C. F. Crocker.

Prof. Barnard came to use it in the following manner:—

I had been endeavouring to photograph the star clouds of the Milky Way with a small Voigtländer rectilinear lens attached to the 6-in. equatorial, but because of the slowness of the lens, had secured but feeble impressions of these clouds. The great light ratio of the old 6-in. lens suggested that it would perhaps serve my purpose. The results of some experiments which I made with it in photographing the Milky Way were very beautiful and intensely interesting. When the importance of the lens for such astronomical work became apparent, Prof. Holden placed it in the hands of Brashear, who refigured it and greatly improved the definition of the star images.

Prof. Barnard gives the dimensions of the lens, and as these are of interest they may be mentioned here:—

Diam. of front lens 5·85 in. = 148·6 mm.
,, back ,, 6·73 ,, 171·0 ,,
Solar focus 42·59 in. = 108·2 cm.
,, ,, 70·2 ,, 178·3 ,,

The distance from the rear surface of the front lens to the surface of the back lens was 12·8 in. A diaphragm of 3·83 in. aperture was placed between the two sets of lenses at a distance of 5·54 in. from the front lens.

The early photographs of the Milky Way and comets were first made with the "Willard" lens in a wooden box camera strapped on to the 6½-in. equatorial, the last-mentioned being used as a guiding telescope. Afterwards the lens, in its wooden box, was fixed on an equatorial mounting made by Brashear, the gift of the Hon. C. F. Crocker, and the telescope named after this donor.

The frontispiece shows the instrument with the 6-in. lens mounted, and also the Crocker dome which contains it.

It should be mentioned here that the new mounting was not equipped with a finder, so Prof. Barnard had to make use of the only telescope which was available for the purpose. This consisted of a small telescope, having only an aperture of 2·4 in., and there was no arrangement for the illumination of the cross threads, so desirable for very dark nights. Prof. Barnard had therefore to employ iron wires sufficiently coarse to be just visible in black relief on the dark sky. By racking out the eyepiece until the star was a little out of focus, he thus formed a disc, which he adjusted not only to be exactly behind the point of intersection of the wires, but of such a diameter that it was eclipsed by the wires with the exception of four small portions which peeped out of the four quadrants; for "following" purposes, these four positions were kept perfectly equal, the slightest inequality being detected and corrected at once. Anyone who has used this method knows how efficient it is, provided the star used for following is sufficiently bright; but, as Prof. Barnard points out, for "following" on a comet which has not a bright nucleus, "the following becomes a serious question, subject to considerable uncertainty, especially if the comet is faint." This drawback accounts, as he remarks, for the ragged condition of the trails of Brook's comet in his photographs. In spite, however, of the inefficiency of the following telescope, Prof. Barnard by his skill achieved wonderful results.

Turning now to the photographs, the page facing each plate is devoted to details of the photograph, such as date, exposure, scale, identification of stars, &c., and a brief description of the principal features. In cases where certain plates call for a more detailed description, further information is placed in the main text.

Thus, for instance, the region of the great nebula of ρ Ophiuchi is so treated. In the description of this plate Prof. Barnard says: "I do not think there is any other region of the heavens so extraordinary as this. . . . One hesitates at any attempt to describe it. Perhaps even more remarkable than the nebulosities are the vacant lanes that run eastward from the great nebula and those in the upper part of the plate." These lanes, as Prof. Barnard has previously published, suggest strong indications of light obscuration by interposing nebulous or other matter in space. This remarkable region is one of many which were discovered by him with the Willard lens. The nebula of ν Scorpii is pointed out as being of far greater interest in the direct evidence it gives of the obscuration of light in space.

Plate 3, showing the region of the great nebula of Andromeda, gives an example of the difficulty of accurately reproducing plates from the original negative. Prof. Barnard is in every case very careful to point out the defects in each reproduction, for sometimes some inequalities of illumination, looking like nebulosities, are really defects of reproduction, even in these plates after so much care has been taken. The nebulous region of 15 Monocerotis is a wonderful photograph, and the reproduction is described as "beautiful." It shows most distinctly the great nearly vacant region beginning near the nebula and running for two or three degrees to the west and then turning north for even a greater distance. The plate illustrating the small star cloud and black holes in Sagittarius is one of numerous other fine specimens of Prof. Barnard's skill, but of which space forbids one to more than mention. No less beautiful than the Milky Way photographs are those showing comets. Among the many illustrated, most instructive are the changes of the forms of Comet I. 1892 (Swift), Comet IV. 1893 (Brooks), and Comet II. 1894 (Gale), series of photographs of which are given. Plate 101 records an interesting picture displaying the trail of the first comet (Comet V. 1892) discovered by the aid of photography.

While Prof. Barnard has brought still more to perfection his collection of astronomical photographs by using lenses more effective than the old "Willard" lens, yet this record of pioneer work is one to be thoroughly proud of, and astronomical literature is greatly enriched by the permanent record contained in this fine volume.

WILLIAM J. S. LOCKYER.

CEREBRO-SPINAL FEVER.

CEREBRO-SPINAL fever is a disease which occurs sporadically, *i.e.*, as occasional isolated cases, or in epidemic form The first authenticated epidemic seems to have been in Geneva in 1805. In 1806 it appeared in the United States, and continued to prevail there for ten years, and again in 1861 to 1864. During this period, and indeed throughout the first half of last century, it was observed in different towns of France and of Italy, in Algeria, Spain, Denmark, etc. In 1854 and for seven years afterwards it raged in Sweden, destroying more than 4000 persons in that country. In 1863 it broke out in Germany and spread from north-eastern Prussia to the south German towns. In 1846 it appeared in many of the workhouses in Ireland, and in 1866–68 a very fatal type of it prevailed in Dublin, and to some extent in other parts of the country. The disease never seems to have established itself in London, or indeed in England, but during the last ten years epidemics of some severity have prevailed in Belfast, Glasgow, and Edinburgh, and during the past year a number of cases have occurred in different parts of the country, particularly in connection with military camps.

Cerebro-spinal fever is also termed *epidemic meningitis*, or *epidemic cerebro-spinal meningitis*, from the fact that the prominent lesion is inflammation of the membranes (meninges) of the brain and spinal-cord. Another name is *spotted fever*, owing to the occurrence of an eruption of hæmorrhagic spots, particularly on the abdomen, which, however, is often absent.

The incubation period varies, but is frequently not more than four or five days, and the onset of the disease is usually sudden and ushered in by headache and vomiting. Stiffness and pain in the neck and retraction of the head are frequent, and twitching of the limbs and muscular tremor are often observed. Mental enfeeblement, stupor, or insensibility may occur, fever is present with prostration and wasting, and weakness or paralysis of various groups of muscles may ensue.

Cases show considerable variation in severity and duration; some are acute, others chronic, some are mild, others severe, and others again very acute and fulminating, so that death may result within twenty-four hours of the onset.

The causative micro-organism is a micrococcus, the "meningococcus" (*Diplococcus intracellularis*), a small spherical microbe measuring about 1/25,000 in. in diameter. It occurs in pairs in groups principally within the cells of the exudation which forms on the membranes; it may also sometimes be found in the blood by culture. The meningococcus, when treated by the Gram staining process, remains uncoloured; it is readily cultivated on media containing serum, and by its cultural reactions can be distinguished from other similar micro-organisms, and does not develop at a temperature below about 75° F. The examination of the cerebro-spinal fluid for the presence of the meningococcus is now practised for purpose of diagnosis of the disease. No drug exerts any specific action upon the disease, but an "antimeningococcic serum" is unquestionably sometimes a valuable curative agent, though at other times it fails. This variation in effect probably depends upon the fact that varieties of the meningococcus exist, and unless the serum has been prepared with the variety for which it is to be employed it is likely to fail.

The disease is undoubtedly spread by contact and possibly in other ways. The meningococcus is sometimes found located at the back of the throat, and may so exist not only in persons who have had the disease, but also in those who are seemingly healthy and have not suffered from the disease; such individuals constitute "carriers" and are sources of infection, and attempts have of late been made to detect such carriers by bacteriological examination, so that they may be isolated. Of preventive measures little of value is known, but recently a trial has been made of vaccinating with killed cultures of the meningococcus, with what result remains to be seen. The presence of the meningococcus in the throat has suggested that the organism enters the body and central nervous system *viâ* the nasal passages.

R. T. H.

NOTES.

The subject of the address to be delivered by Sir William Ramsay at the annual meeting of the British Science Guild to be held this afternoon is "The National Organisation of Science." Owing to the war, the annual dinner of the guild will not be held this year.

The annual general meeting of the Eugenics Education Society will be held this afternoon at the Grafton Galleries, Grafton Street, W., and the presidential address will be delivered by Major Leonard Darwin upon the subject, "Eugenics During and After the War."

Sir Almroth Wright has been awarded the Lecomte prize by the Paris Academy of Sciences. The prize, which is of the value of 2000*l*., is awarded triennially.

We notice with much regret the announcement of the death on June 26, from heart failure, of Dr. R. H. Lock, inspector at the Board of Agriculture and Fisheries, sometime fellow of Gonville and Caius College, Cambridge, at thirty-six years of age.

Mr. Tennant said in the House of Commons on June 23 that practically all the laboratories in the country have been placed at the disposal of the War Office. Great benefit has been derived by the War Office from advice and information received from the Royal Society, the National Physical Laboratory, the universities, and other bodies, and Mr. Tennant took the opportunity of conveying to these scientific and learned bodies the thanks of the Army Council.

In the House of Commons on June 28, Sir Philip Magnus asked the Prime Minister whether, having regard to the necessity for the purposes of the war of organising the services of fellows of the Royal Society and of other scientific bodies and also of the professors and staffs of our universities and technical schools, and of mobilising the scientific and technical resources of the laboratories and workshops of such institutions, and, having regard to the importance of creating a central committee or bureau for considering scientific problems that arise out of the war, for testing and developing inventions from whatever source they may originate, and reporting upon them to the special Department of State concerned, he will afford an opportunity of discussing the subject in the House? The reply of the Prime Minister was that opportunities would arise for this discussion.

A useful ethnological collection has been made in Siberia by the University of Pennsylvania's expedition, according to news recently received in Philadelphia from its leader, Mr. H. U. Hall. Last summer was spent by the party among the Samoyed and Dolgan tribes, and last winter among the Tungus and Yakuts, between the Yenisei and Lena Rivers. The effect of the war has been felt by the expedition in raising the prices of everything and making "transportation" difficult.

The annual meeting of the General Board of the National Physical Laboratory was held in the rooms of the Royal Society on Tuesday, June 15, when the annual report and accounts for the year 1914–15 were adopted for presentation to the president and council of the Royal Society, and the programme of work for the coming year was approved. This year the usual gathering of visitors at Teddington, to meet the members of the General Board and to inspect the laboratory, will not take place. Twenty-five per cent. of the staff are on active service.

The council of the Royal Society of Arts has arranged with Prof. Vivian B. Lewes to give a short course of special lectures during the recess on "Modern Munitions of War." Three lectures will be given, on Wednesday afternoons, July 7, 14, and 21. The first lecture will deal with "Guns and Propellants," the second with "Mines, Shells, and High Explosives," and the third with "Poison Gases and Incendiary Bombs." The course will be under the Fothergill Trust. The lectures will be open to all fellows of the society, who can admit their friends personally, or by the usual tickets. Tickets will also be issued gratuitously to any persons interested in the subject who may apply to the secretary, Sir Henry Trueman Wood, at the offices of the society.

Engineering for June 25 announces the death of Mr. Charles Colson, C.B., late Deputy Civil Engineer-in-Chief of the Admiralty. Mr. Colson, who died at St. Leonards on June 8, at the age of seventy-six, was connected with the War Department in early life, and joined the Admiralty in 1866. For many years he was assistant-engineer on the Portsmouth Dockyard extension. In 1883 he was selected to go to Malta to design a new graving dock for the Navy at that port. He held the post of Superintending Civil Engineer of Devonport Dockyard from 1892 to 1894, when he was appointed Assistant-Director of Civil Engineering Works at the Admiralty. He was the author of a book on docks and dock construction which has been widely used, and he contributed several papers to the Proceedings of the Institution of Civil Engineers.

We record with regret the death of Mr. Howard Marsh, master of Downing College, and professor of surgery in the University of Cambridge. He died at The Lodge, Downing College, on June 24, aged seventy-five. After receiving his training at St. Bartholomew's Hospital he applied himself to surgery, becoming lecturer on surgery at his school. He was justly regarded as a leading authority on diseases and treatment of joints. He was an active member of the council of the Royal College of Surgeons, advocating the enfranchisement of the members of the college. In 1903, when he had reached an age at which many consultant surgeons seek retirement, he entered a new field of endeavour as professor of surgery in the University of Cambridge, where his energy and public spirit were given full scope. In 1907 he became master of Downing, succeeding Dr. Alex. Hill. His predecessor in the chair of surgery was the late Sir George M. Humphry.

It is a wonderful story, in the *Daily Chronicle* of June 23, of the death of Dr. Chaillou. He was head of the anti-rabies department of the Pasteur Institute in Paris. Those of us who remember the war of 1870–71 will remember what havoc it made of Pasteur's work. The institute had not then been founded; the work was done in the laboratories in the rue d'Ulm. Pasteur's young men went off to the war; Henri Ste. Claire Deville met his death there. When Pasteur died, in 1895, Roux was his successor, as head of the institute. History repeats itself; the Pasteurians have gone off to the war; and Chaillou has met his death there. On April 21 he had "demanded and obtained the perilous mission of disinfecting a battlefield near the enemy's trenches." At night, alone, he "reconnoitred the position"; he found work enough for twelve nights; the state of the battlefield must not be described here. On the night of April 24 he was within seven yards of the enemy's trenches, and was killed. Strange, to think of this man of science, accustomed to work of the very utmost minuteness and microscopical accuracy, stumbling about, in the dark, with a tin of disinfecting powder, among the piles of unburied dead. Shells fell on him and his men: eleven were killed. Every day and every night precious lives, cultured and expert men, are flung away like this. We say that there will be a "shortage of doctors" when the war is over; but we scarcely stop to think of the tragedy in that off-hand phrase. The waste of the lives of the experts is terrible. Here was a man trained and disciplined in one of the most complex of all the sciences; and he is put to scavenging, to the very roughest and least skilled work, and he lays down his life for his friends over that. May his name live in the great institute where he worked more delicately for the good of mankind.

By the death of Dr. G. C. M. Mathison, which took place at Alexandria on May 20, in consequence of wounds received in Gallipoli, the sciences of physiology and pathology have suffered a serious loss. The taking away of young and enthusiastic workers, of which this is by no means the only instance, is one of the saddest things in the war. Dr. Mathison's chief scientific work was concerned with the analysis of the phenomena of asphyxia in its effects on the nervous system. He showed that the results both of deficient oxygen supply and also of increased accumulation of carbon dioxide are due to a common factor, namely, the rise of hydrogen-ion concentration in the blood. The various nerve centres were shown to be sensitive in different degrees to this agent; thus the bulbar centres are excited by one-fifth of the increase that the spinal centres require. In deprivation of oxygen without accumulation of carbon dioxide, it was shown that acids may be produced by disorganisation of the cells of the nerve centres themselves, a process which takes place suddenly and must be regarded as pathological. Deficiency of oxygen was found also to produce heart block by depression of conductivity in the auriculo-ventricular connection. In work done with the collaboration of Barcroft, Mathison showed that the rate at which oxyhæmoglobin gives up its oxygen to the tissues is greatly increased by a rise in the concentration of hydrogen ions, and that rises of such an extent as to be of importance in tissue respiration may occur when the oxygen supply is deficient. The effect of potassium on the vascular system was also investigated and found to be of a dual nature. While it is depressant on the heart, it produces contraction of the arterioles, both by direct action upon the muscular fibres and by excitation of vaso-constrictor centres in the spinal cord and the bulb.

THE death of Lieut. R. B. Woosnam, killed in action at the Dardanelles on June 4, adds one more name to the steadily increasing list of workers in science who have given up their lives for their country in this great war. Lieut. Woosnam served with the 2nd Worcestershire Regiment in the South African war, and it was during that period that he first became known to the Natural History Museum by sending to that institution a number of small mammal and bird skins prepared so well that it was at once noticed that they were the work of a skilled collector and true naturalist. At the close of the war Woosnam offered his services to the museum as a collector, and on the offer being accepted he gave up soldiering for the time being. In his new capacity he carried out a difficult piece of zoological exploration through the Kalahari desert to Lage Ngami, and in October, 1905, he was appointed leader of the important expedition organised by the museum for the exploration of the Ruwenzori range in equatorial Africa. His companions were Mr. R. E. Dent, a former brother officer in the Worcestershire Regiment, the Hon. Gerald Legge, Mr. Douglas Carruthers, and Mr. A. F. R. Wollaston. The expedition reached a height of 16,794 ft., and Woosnam records that butterflies, moths, and diptera were seen on the snow up to 16,000 ft., blown there by the almost constant wind. On the bare rocks above the snow-line a few worms, lichens, and mosses were seen. As a result of the undertaking the National Museum was enriched by a large number of species new to science, and a very valuable addition made to our knowledge of the fauna and flora of tropical Africa. In 1911 Woosnam was appointed by the Secretary of State for the Colonies game warden in British East Africa. He very quickly surmounted the difficulties of the position, and it speaks volumes for the fine nature of the man that though he carried out his duties in the strictest manner and confiscated with unsparing hand illegally obtained sporting trophies and other objects, there was no more popular official in the Protectorate. He was mainly instrumental in getting together the International Conference for the Protection of Wild Animals in Africa which met in London last year. It is no secret that he formulated stringent plans, which were virtually adopted, for the effective carrying out of the object of the conference. Now, alas! all this is at an end, and with it has passed away a man of sterling character, of a lovable disposition, modest and unassuming almost to a fault, an unflinching adherent to duty.

THE thirteenth annual session of the South African Association for the Advancement of Science will be held at Pretoria, from Monday, July 5, to Saturday, July 10, inclusive, under the presidency of Mr. R. T. A. Innes, Union Astronomer. The sections and their presidents will be as follows:—*A*—Astronomy, Mathematics, Physics, Meteorology, Geodesy, Surveying, Engineering, Architecture, and Irrigation, F. E. Kanthack; *B*—Chemistry, Geology, Metallurgy, Mineralogy, and Geography, H. Kynaston; *C*—Bacteriology, Botany, Zoology, Agriculture, Forestry, Physiology, Hygiene, and Sanitary Science, C. P. Lounsbury; *D*—Anthropology, Ethnology, Education, History, Mental Science, Philology, Political Economy, Sociology, and Statistics, J. E. Adamson. Among the papers to be read are the following:—The fault system of the south of Africa, Prof. E. H. L. Schwarz; Some South African radio-active minerals, Prof. P. D. Hahn; Darwin's theory of natural selection, tested in the light of our knowledge of Crassulaceæ, Prof. S. Schönland; The economy of termites, C. Fuller; The history of the ostrich industry in South Africa, R. W. Thornton; Anti-venomous serum and its preparation, F. W. FitzSimons; The inheritance and characters of certain cross-bred sheep, J. Burtt-Davy; The Bagananoa (Malaboch), with notes on the traditional history of the tribe, Rev. N. Roberts; Sesuto etymologies, Rev. W. A. Norton; practical education, W. J. Horne; and The economics of the east coast fever, Rev. J. R. L. Kingon. A popular evening discourse will be delivered by Mr. C. W. Mally, on the house-fly under South African conditions, and one by Dr. E. T. Mellor on the Witwatersrand Goldfields. The medal and grant for 1915 have been awarded to Mr. C. P. Lounsbury, chief of the division of entomology, Union Department of Agriculture, and will be presented during the session.

THE National Clean Milk Society (2 Soho Square, London, W.), which has been formed to improve the milk supply of Great Britain and Ireland, has published a pamphlet showing how by a system of marks it is possible to conduct the inspection of dairy farms in an efficient and educational manner. The score-card system which has been developed so largely in the United States for judging stock, agricultural produce, etc., has also been applied to the inspection of dairy farms, town dairies, etc. By making alterations that would bring the score-card more in touch with British conditions, it has been possible to arrive at what promises to be a most satisfactory way of judging of the sanitary condition of any farm that is producing milk for human consumption. The score-card is divided into two main sections, one section dealing with equipment, the other with methods, and 60 per cent. of the total marks is allotted to the latter. Most excellent explanatory notes are appended to the score-card, and are presumably intended for the guidance of the inspector. A perusal of them would be of great value to the farmer himself, for frequently lack of cleanliness is due more to failure to appreciate the necessity of being careful in the handling of such an important food as milk than to any desire to evade regulations. Sanitary inspectors in particular should see this pamphlet, and if every landowner would take the trouble to observe how large a proportion of marks on the score-card depend upon the cowshed there might be improvements in farm buildings.

DR. R. HAMLYN-HARRIS, the director of the Queensland Museum, has set himself the task of forming a collection of the "Implements of Superstition and Magic" used by the natives of Queensland. As these are dying out with appalling rapidity, ethnologists the world over will be grateful to him. A most welcome summary of the results so far achieved appears in vol. iii. of the Memoirs of the Queensland Museum. He prefaces his account with a word of warning which in the interests of science cannot be too widely circulated. The wily aboriginal, having discovered that his implements and weapons have a marketable value, has taken to manufacture on an extensive scale, but such specimens bear, in every detail, the mark of the bungler. Nevertheless, it would seem that tons of material are being exported to museums all over the world by unscrupulous dealers who are inciting the natives to pursue this reprehensible means of obtaining money or its equivalent. Death-bones, quartz crystals, magic stones, and rain-sticks are severally described in this essay, which contains a valuable collection of myths and customs which are fast disappearing.

THE concluding portion of the paper by Prof. Flinders Petrie on the Stone age in Egypt, published in *Ancient Egypt*, part iii., for 1915, raises a very interesting question of synchronism. The writer notices a striking resemblance between the coarse flakes which abound in prehistoric Egyptian graves with those of the Magdalenian Cave type. In other cases the snubbing of the edge by scraping is characteristic of European Aurignacian flints. The Magdalenian flint types in Egypt are associated with bone harpoons, which are also of that age in Europe. A bone harpoon found in Egypt belongs to the first and part of the second prehistoric civilisation, say 8000–6000 B.C. "This," he writes, "raises the question whether it will be possible to extend the Magdalenian Cave period as late as the Egyptian graves of about 7000 B.C., or to trace a descent of the type to a later time. This connection is an additional reason for keeping to the Egyptian chronology, and not adopting the arbitrary theories of Berlin which would bring down these Magdalenian types to about 3500 B.C." This suggestion of a possible synchronism between the Cave periods of Europe and graves in Egypt which can be dated with some approach to certainty may lead to important results. It is unfortunate that so much haphazard collection of flints has gone on in Egypt, without regard to their seriation or characteristics, and thus evidence of much value has been lost.

THE Miocene insect beds of Florissant, Colorado, promise to yield an even richer harvest than the celebrated beds of Oeningen in Baden. Prof. T. D. A. Cockerell, in the Proceedings of the Academy of Natural Sciences of Philadelphia (part iii., vol. lxvi.), describes a number of species new to science collected by Prof. Wickham. In an excavation about 20 ft. long and 6 ft. deep he obtained more than ninety species of beetles, of which at least forty are new to science. But various other groups are also represented in this collection, of which apparently sixty are new species.

A NEW addition to the list of British fishes is made by Dr. R. F. Scharff in the *Irish Naturalist* for June. This is the long-finned bream (*Brama longipennis*) which was captured on May 18 last year, off the west coast of Valencia Island, Co. Kerry. Though brilliantly coloured at the time of capture, by the time it had reached the island it had faded to a uniform grey hue. Only one other species of the genus has been recorded from Irish waters. This is Ray's bream (*Brama raii*), which was recorded in 1888. To the same number Dr. Scharff contributes some interesting notes on Irish sharks.

THOUGH observations on the birds attracted to lightships and lighthouses during migration have been kept with much exactness during a number of years, no similar records had been made in regard to insects which in like manner are attracted by light, until recently, when the matter was taken up by Mr. W. Evans. The conclusion of his report on Lepidoptera and other insects at Scottish lighthouses appears in the *Scottish Naturalist* for June. It is usual, he remarks, "to think of moths alone as night-fliers, and attracted by light, but . . . not a few other insects have similar habits, and are similarly attracted. . . . Both sexes come to the lanterns, but as a rule males predominate." He also makes some interesting observations on the dominance of certain colour variations.

CONCHOLOGISTS will doubtless welcome the announcement of the rediscovery of Pourtales's Haliotis. This is made by Mr. J. B. Henderson in the Proceedings of the U.S. National Museum (vol. xlviii., 1915). The first intimation of the occurrence of this genus in western Atlantic waters dates so far back as 1869, when a specimen was dredged up in the Straits of Florida. This was unfortunately destroyed in the great Chicago fire before it could be described. Twenty years later it was described from memory by Dr. Dall, who named it in honour of Count Pourtales, under whose supervision the original dredging operations were carried out. Two years ago Mr. Henderson, while dredging from the *Eolis,* along the inner edge of the Pourtales Plateau off West Key, in ninety fathoms, secured a second specimen of Haliotis, which proved on examination to be an immature specimen of the long-lost Pourtalesii.

THE reclamation of peat bogs is always a matter of economic importance, and the results achieved by sowing *Pinus pinaster* directly on a peat-bog, described in *Irish Gardening* for June, are worthy of wider notice. Two photographs are reproduced, one showing the depth of the peat where the seeds were sown in the west of Ireland, the other three of the young trees, four years old. The soil is fatal to the Scots Pine, but *P. pinaster,* if sown on the spot, thrives remarkably. The tree transplants badly, and for this reason the success attending the method adopted at Abbeyleix by Mr. Macgregor is very interesting.

No. XXVIII. of vol. vi. of Notes from the Royal Botanic Gardens, Edinburgh, for May, is occupied by a useful paper in the form of a key to the Labiatæ of China, by Mr. S. T. Dunn. The key is based largely on the collections in the Hong Kong herbarium, and has been constructed on practical lines. Hong Kong being essentially the key to the botanical position as regards China, we welcome any work, based on the collections of that herbarium, tending to set out in orderly form the vast wealth of the Chinese flora as regards particular natural families. Even now it is not possible to arrive at a definite phytogeographical survey of the empire as regards any one group of plants, but a key such as that just published is of value in helping forward the more detailed study of the flora of China.

THE condition known as Peloria, in which the exceptional development of complementary irregularities make a typically irregular flower regular, is fairly commonly met with in foxgloves and snapdragons under cultivation; indeed, in both plants a definite varietal form, with either the terminal or all the flowers peloric or regular, appears to be fixed and to come true from seed. In the foxglove the variety is known as var. *monstrosa,* and the terminal flower is a more or less regular erect bell, similar to the flower of a Campanula. In Antirrhinum a varietal form has been so far fixed by Lorenz, of Erfurt, that 60 per cent. of the plants raised from seeds bear peloric flowers; this form is figured in "Gartenflora" (1904, p. 113, t. 1524). Here all the flowers are tubular and perfectly regular, but a form recently received from a correspondent resembles the foxglove, variety *monstrosa,* in having the terminal flower only regular, with the characteristic lower lip of the snapdragon, forming a complete fringe round the actinomorphic tubular flower, while all the other flowers are zygomorphic. A further peculiarity of these pleoric varieties is that the terminal flower of the raceme is the first to open, whilst in normal forms the terminal flower is the last to expand.

HELMHOLTZ's magnification formula of our elementary text-books on optics is known to be a particular case of a number of interesting reciprocal theorems; for example, the property that in a system of lenses the *angular* diameters of the object and image as seen from any position are inversely proportional to the *linear* diameters of the sections of the incident and emergent small pencils where they meet the eye. In the *Atti dei Lincei,* xxiv., 7, Prof. Levi Civita gives a general dynamical investigation of these reciprocal relations, including Straubel's theorem, and with applications to multi-dimensional hyperspace. This is based on the analogy between trajections in dynamics and paths of rays, which analogy results from the principles of least action and time respectively.

THE rapid increase of the electrical resistance of pure iron with temperature makes it very desirable that the behaviour of iron resistance thermometers should be thoroughly investigated with a view to their introduction into common use. Such an investigation has been made by Messrs. G. K. Burgess and I. N. Kellberg, of the United States Bureau of Standards, and the results are published in the May number of the journal of the bureau. The wire used was 99·98 per cent. iron, 0·24 millimetre in diameter, and was wound on a porcelain insulator and enclosed with a similar platinum wire in an evacuated quartz tube. Six such combined thermometers were made and annealed at 1000° C. In the subsequent comparisons of the resistances of the platinum and iron wires at various temperatures the resistances were determined to the equivalent of 0·005° C. In all cases the resistance of pure iron was found to increase regularly to about 750° C., the temperature coefficient of increase reaching a maximum about seven times that of platinum at that point. At 757° C. the critical point A_2 is reached, and the coefficient decreases. At 894° C. the second critical point, A_3, is reached, and the resistance decreases over a range of 10° C., to increase again at higher temperatures. On cooling the A_3 change occurs at 880° C., while the A_2 change occurs again at 757° C.

THE June issue of the *Journal* of the Franklin Institute contains a second paper by Sir Robert Hadfield on sound steel for rails and structural purposes, the first having been published in February. The present paper gives some details of the production for the Pennsylvania Railway Company of one hundred tons of rail ingots made at Sheffield under his "sound steel" system. The dimensions of the ingots were 5 ft. 4 in. by 18 in. square. They were fed from sandheads, which permitted an average of 130 lb. of fluid steel to pass into the ingot, which contracted during freezing, thus continuously "following up" any pipe that tended to be formed. The average capacity of the cavity on the top of the ingots was 3·19 per cent. of the total capacity of the ingot. The author claims that after cutting off 10 per cent. from the top of the ingot the remaining 90 per cent. is sound, entirely free from blowholes, segregation, cr piping. Ingots sectioned through the long axis and photographed appear to bear out this contention, at any rate so far as soundness is concerned. In the rail ingot, as ordinarily cast, a discard of upwards of 40 per cent. is sometimes necessary, and even in the sound portion segregation is always present to a greater or less extent. It is interesting to note that the average carbon percentage in the ingots is 0·63—a considerably higher figure than any English railway company permits. This gives a harder but more brittle rail. The wear in practice of rails rolled from these ingots will be watched with considerable interest.

THE *Scientific American* celebrated its seventieth anniversary on June 5, and the number for this date contains an interesting retrospect through the inventions and scientific discoveries of the past seventy years. When the journal was first established, we had only Davy's arc and electrolysis, Oersted and Ampère's revelations in electrodynamics, Daguerre's photography, Henry and Faraday's work in induction, and Joule's mechanical equivalent of heat. The telegraph and the reaper had just been born. Much of the transformation which has marked the last seventy years has taken place within the lives of men still with us. Prior to the invention of the telephone, our contemporary considers that the decade 1840–50 was the most fruitful in invention; during this period the reaper, the vulcanisation of rubber, the sewing-machine, and the telegraph were perfected. The decade beginning with 1880 saw an outburst of inventive activity that dwarfed all similar periods in the history of invention. It seemed that the discoveries in electricity during the last three or four years of the previous decade had been the signal for the pent-up genius of the world to be let loose. In the 'eighties the generation, transmission, and utilisation of current, the dynamo, the transformer, and the motor were all made practical propositions on a large and commercial scale for the first time. The electric furnace was perfected in the latter part of this period. The Harvey process for hardening armour plate was invented in 1888; smokeless powder, the Westinghouse brake, the transparent film which foreshadowed the moving picture and the pneumatic tyre are also contributions of the same decade. There are a large number of photographs of historical inventions and inventors included in this number, and there is also an interesting autobiographical sketch by Mr. Nikola Tesla.

IN view of the great interest at the present time in the Conventions and signed Declarations of the First and Second Hague Conferences, and particularly because of the need of accurate information as to ratifications of and adhesions to the Conventions and Declarations relating to war, the Carnegie Endowment for International Peace has prepared a series of pamphlets in order that the public may learn from trustworthy sources the status of these international agreements and the extent to which the Powers now at war are bound by their provisions. We have received copies from Washington of seventeen of these pamphlets, and find that among the subjects of vital importance considered are: the declarations of 1899 concerning asphyxiating gases and expanding bullets, and prohibiting the discharge of projectiles and explosives from balloons; and the conventions of 1907 relative to the laying of automatic submarine contact mines and concerning bombardment by naval forces in time of war.

THE Open Court Company, 149 Strand, W.C., has ready for publication "A Budget of Paradoxes," by Augustus de Morgan, revised and edited, with full bibliographical notes and index, by Prof. David Eugene Smith, professor of mathematics, Teachers College, Columbia University, New York.

MESSRS. G. P. PUTNAM'S SONS announce for early publication:—"The Alligator and its Allies," by Prof. A. M. Reese; "Plane Trigonometry," by Prof. A. M. Harding and J. S. Turner; and "Field Book of Western Wild Flowers," by M. Armstrong and Prof. J. J. Thornber.

THE announcements of the Cambridge University Press include:—"Mimicry in Butterflies," by Prof. R. C. Punnett; "The North-West and North-East Passages, 1576–1611," edited by P. F. Alexander (the first volume in the series of "Cambridge Travel Books"); and "Stories of Exploration and Discovery," by A. B. Archer.

ERRATA.—In Prof. O. W. Richardson's Royal Institution discourse printed in NATURE of June 24, p. 468, col. 2, line 12, for "twice" read "half"; p. 469, col. 1, table, for "calories per n" read "calories per gram-molecule of electrons."

OUR ASTRONOMICAL COLUMN.

THE ORIGIN OF COMETS.—In the *Publikationer og mindre Meddelelser fra Kobenhavns Observatorium*, No. 19, Prof. Elis Strömgren publishes a research which he has concluded with the help of Mr. J. Braae on the subject of the origin of comets. In the introduction the author refers to the results of previous workers, and suggests that the question as to whether comets came originally from interstellar space or were formed in the solar system, depends on the method of discussion adopted. The author describes fully the procedure he has used in the present research, which involves the backward computation of planetary perturbations for eight comets, and gives the numerical calculations. He is thus led to form the conclusions that there is not one warranted hyperbolic orbit among the comets of the solar system, and that all the comets yet observed have their origin in the solar system.

COMPANIONS TO MELLISH'S COMET.—In the Astronomical Notes of the May–June number of the Journal of the Royal Astronomical Society of Canada, reference is made to two companion bodies near Mellish's comet discovered by Prof. Barnard. One of these bodies was conspicuous and had a distance of 28″ and position angle of 285° on May 12 at 19h. 36m. The other was faint, and occupied an intermediate position on the same line. The above confirmation appeared in the Harvard College Observatory Bulletin, No. 580.

THE ABERRATION CONSTANT AND LATITUDE VARIATION.—The floating zenith-telescope designed by the late Mr. Bryan Cookson has been in use since 1911 at the Royal Observatory, Greenwich, having been lent by the Cambridge University. It has been employed in the determination of the aberration constant, and a preliminary discussion by Mr. H. S. Jones of three years' observations with it appears in the May number of the Monthly Notices of the Royal Astronomical Society. This communication represents the results derived from observations made between September, 1911, and December 31, 1914, and the discussion is based on measures of 479 plates. The value of the aberration obtained is given as 20·467″ ± 0·006.″ The instrument being designed primarily for the determination of the aberration, it is interesting to note that, as a by-product of the investigation, excellent values of the latitude variation have been derived. The paper contains a representation in the form of curves of the Cookson results, the international results, and the latter without the Z or Kimura term. The Cookson latitude variation is more in agreement with the last-mentioned curve, and it is pointed out that the agreement on the whole is improved, and more particularly so during the latter half of 1913, when the Z term attained its greatest value during this period.

THE HENRY DRAPER MEMORIAL.—In the work of the classification of the spectra of stars Miss Annie Cannon's name is well known, and as an able member of the staff of the Harvard College Observatory her position renders her admirably suited to describe the pioneer work and progress of the Henry Draper Memorial. Under this title Miss Cannon communicates to the May–June number of the Journal of the Royal Astronomical Society of Canada a most interesting account of the work that has been carried on at both the Cambridge and Arequipa stations of the Harvard College Observatory in the name of Henry Draper, the memorial having been presented by Anna Palmer Draper, the widow of that distinguished investigator and astronomer. A very clear survey is given of the progress of the many lines of research undertaken and successfully accomplished, but these cannot be referred to here, for they are too numerous and space forbids. The enormous amount of data collected in the form of glass negatives is now being adequately dealt with by the generosity of Mr. George Agassiz, and the work of identification and reduction placed on a scientific basis. To give an idea of the work (other than observational) being done at the present time, Miss Cannon states that 199,196 spectra have been classified, and about 150,000 of these have been identified. It is hoped that the observations for the New Draper Catalogue will be finished in six months, and that the printing will be started soon after that time. It is proposed then to make a very careful study of the distribution of the various classes of stellar spectra, "as a portion of the contribution of the Henry Draper Memorial to the greatest of all investigations, the constitution of the sidereal universe." Attention should be directed to the excellent reproductions, which include a portrait of Henry Draper, views of the Cambridge and Arequipa stations, types of stellar spectra, spectra of stars in region of R Cygni, and many others.

THE REPORT OF THE CAMBRIDGE OBSERVATORY, 1914–15.—In the *Cambridge University Reporter* for June 19 a report is given of the proceedings in the Cambridge Observatory for the period May 19, 1914, to May 18, 1915. The director states that for various reasons not much progress could be made with observational work during the first half of the year under review, but from the beginning of 1915 the conditions of work became more normal. The Sheepshanks equatorial has been the chief instrument in use, and this has been mostly employed in securing photographs to complete the series of plates required for the parallax programme. At present the exposures at each epoch are made on separate plates, but it is hoped ultimately to secure the exposures at the two epochs on the same plate. The meridian circle has been confined to observations for time determination. The Northumberland equatorial seems to be used only on Saturday evenings during term time for the members of the University and their friends. As regards publications, the printing of the Ledger of the Zone Catalogue is near completion so far as the main catalogue is concerned.

THE DESTRUCTION OF FLIES.

A PAPER on "The Destruction of Flies and the Disinfection of Corpses in the Battle Line," by M. E. Roubaud, is published in the *Comptes rendus* of the Paris Academy of Sciences for May 25. The author remarks that the hot weather will bring with it the menace of fly outbreaks and consequent epidemics of diseases, and that he has collected the simplest methods of dealing with the problem. For house-flies, he recommends heavy coal tar oils sprayed on the surface of excrement, etc., to prevent access of flies; for sanitary purposes he advises the following:—

Ferric sulphate	2500 grams.
Heavy tar oil	500 c.c.
Water	10 litres.

This is stated to be deodorising, larvicidal, and protective against flies.

Heavy tar oils are toxic to plants, and cannot be used when the material is to be employed as manure. Shale oils (miscible oils) he considers more toxic to plants than to larvæ, and he deprecates their use. Cresyl—*i.e.* miscible cresol—at 5 per cent. in water is not harmful to plants, and manure heaps are to be treated with 15 litres (four gallons) per superficial cubic metre. The exposed areas of the manure heap are then to be protected with a watering of 10 per cent. solution of ferric sulphate. This double treatment is to be carried out twice, in June and in

August; fresh manure as added is to be treated with ferric sulphate.

In regard to blow-flies, M. Roubaud discusses means of preventing access of flies to dead bodies, and the disinfection of corpses. In the first he states that heavy tar oil is to be used, as it preserves animal tissues when 10 per cent. cresyl, chloride of lime, formol, milk of lime, and 5 per cent. phenol fail to do so. Ferric sulphate is to be used as a protective covering, either powdered on or applied as 10 to 20 per cent. solution. The salt forms stable compounds with the tissues which cannot be attacked by flies, and the solution kills eggs and larvæ; the three substances required at the front then are ferric sulphate, heavy tar oil, and cresol.

Some of the author's statements, which are given without proofs, cannot be unreservedly endorsed; for example, it is practically certain that a dead horse powdered with ferric sulphate will still breed innumerable flies unless it is periodically treated. No superficial treatment will clear a superficially dry manure heap of maggots; only a vapour treatment applied in liquid form. Also, a 10 per cent. solution of ferric sulphate is a very expensive dressing unless the substance is available in enormous amount; and one of the difficulties of the front is the transport of material. Concentrated treatments are required if possible, not 10 per cent. treatments at great bulk.

The problem of dealing with flies is very difficult, and is receiving much attention. One aspect is being carefully dealt with in this country, and the results will be available very shortly. This is the question of the treatment of the great aggregation of stable manure. The War Office have apparently accepted the American view of the value of borax; already a treatment with volatile liquid at a third of the present cost of borax has been found, which is satisfactory in that it spreads in the manure heaps and is not simply a superficial treatment; and it does not affect the value of the manure for horticultural purposes. Plants will stand very strong applications of volatile organic compounds, far stronger than are required to kill fly maggots, but which compounds are the best has yet to be determined.

AIR POLLUTION.

The Air Pollution Advisory Board of the Sanitary Committee of the Corporation of Manchester has recently issued its first report. We are told that this Board came into existence two years ago as the result of a memorial presented to the Corporation by members of various scientific and other societies in the city with the object of examining the latest and best methods of eliminating the smoke evil and of diffusing information on the subject.

The Board consists of representatives of various committees of the Corporation, distinguished men of science, and influential members of numerous public bodies. It is divided into four sections, namely, the chemical, statistical, administrative, and engineering sub-committees. This is not the first occasion on which the public spirit of Manchester citizens has been inspired by the smoke nuisance and exercised itself in an attempt to suppress it. In 1891 a committee of the town gardening section of the Manchester Sanitary Society issued a report on some of the evils of smoke affecting vegetation and the amount of daylight; and in 1895 a "committee for testing smoke-preventing appliances" published a voluminous and comprehensive report on the various forms of apparatus used in steam boilers which were alleged to diminish or remove smoke.

What the ultimate fate of these two committees was, the writer is unable to say; but though their activities ceased, there is no doubt that they stimulated an interest in the subject which led not only to the formation of the present Board, but had the effect of inducing other municipalities to adopt a similar action. Work of the same character is now being carried on in fifteen other cities. This growing interest which has spread out from Manchester in ever-widening circles also led to the formation of a Local Government Board Committee on Smoke Abatement, which held numerous meetings in the first half of last year.

The present report deals mainly with the amount, nature, and extent of air pollution by smoke. The methods, which need not be described in detail, are based upon previous investigations of this character, and the results are not essentially different from those already recorded by other observers.

Valuable as the information is as indicating the extent of atmospheric contamination (which is as injurious as it is wasteful and unnecessary) and in keeping public interest alive to the importance of the economic use of fuel, the accumulation of statistics of a nature already well authenticated will not of itself bring about any radical reform.

We are glad to see, therefore, that the Board has in contemplation the study of all domestic coal-consuming grates and their efficiency, and an extensive propaganda by pamphlets, lectures, and exhibitions among builders and tenants in relation to domestic heating by coal, coke, gas, and electricity. Although a good deal of pioneer work has been done in this direction by various smoke abatement societies, it is just one of the subjects on which the views of the community are so firmly welded to the past that unremitting agitation is necessary before the deeply-rooted tradition in the efficacy of the old-fashioned coal fire can be loosened. When this work is complete, the time will be ripe for the consideration of more drastic measures of smoke abatement, and there is no doubt that had not the advent of the war postponed the deliberations of the Smoke Abatement Committee of the Local Government Board, the report of that committee would have greatly strengthened the hands of the municipalities in any future legislation which they may have in view.

In conclusion, we can only congratulate the Manchester Sanitary Committee on the scientific way in which it has set about steadily accumulating evidence and wish it a full measure of success in achieving its ultimate object.

J. B. C.

RADIATIONS FROM EXPLODING ATOMS.[1]

It is now well established that the radio-active substances are undergoing spontaneous transformation, and that their characteristic radiations the α, β, and γ rays—accompany the actual disintegration of the atoms. The transformation of each atom results from an atomic explosion of an exceedingly violent character, and in general results in a liberation of energy many million times greater than from an equal mass of matter in the most vigorous chemical reaction.

In the majority of cases the atomic explosion is accompanied by the expulsion of an actual atom of matter—an α particle—with a very high speed. It is known that the α particle is an atom of helium which carries two unit positive charges, and which leaves the atom with a velocity of about 10,000 miles per second. In some transformations no α particle is ejected, but its place is taken by a swift β particle or electron. These β rays carry with them

[1] Discourse delivered at the Royal Institution on Friday, June 4, by Sir Ernest Rutherford, F.R.S.

a large amount of energy, for in some cases they are expelled very close to the velocity of light, which is the limiting velocity possible for such particles. The expulsion of high-speed β particles is usually accompanied by the appearance of γ rays, which correspond to X-rays, only of greater penetrating power than has so far been obtained from an X-ray tube even when a high voltage is employed. The emission of energy in the form of γ rays is not negligible, for in some cases it is even greater than the energy emitted in the form of high-speed β particles, and may amount per atom to as much as 20 per cent. of the energy released in the form of a swift α particle.

By the application of a high voltage to a vacuum tube it is quite possible to produce types of radiation analogous to those spontaneously arising from radium. For example, if helium were one of the residual gases in the tube, some of its atoms would become charged, and would be set into swift motion in the strong electric field. In order, however, to acquire a velocity equal to the velocity of expulsion of an α particle, say, from radium C, even in the most favourable case nearly four million volts would have to be applied to the tube.

In a similar way, in order to set an electron in motion with a velocity of 98 per cent. the velocity of light, at least two million volts would be necessary. As we have seen, it has not so far been found possible to produce X-rays from a vacuum tube as penetrating as the γ rays. The study of the radiations from radio-active substances is thus of especial interest, not only for the information obtained on the structure of the atoms themselves, but also in providing for investigation special types of radiation of greater individual intensity than can be obtained by ordinary experimental methods. The enormous energy of motion of swift α and β particles must exist in the atom before its disintegration, either in a potential or a kinetic form, and may arise either from the passage of the charged particles through the intense electric fields within the atom, or from the very swift motion of these particles within the atom before their release. In any case, there can be no doubt that electric fields, and possibly magnetic fields, of enormous intensity exist within the very small volume occupied by the essential structure of the atom—fields many million times greater in intensity than we can hope to produce in laboratory experiments.

In order to explain certain experimental results, I have suggested that the main mass of the atom is concentrated within a minute volume or nucleus, which has a positive charge, and is of dimensions exceedingly minute compared with the diameter of the atom. This charged nucleus is surrounded by a distribution of electrons which may extend to distances comparable with the diameter of the atom, as ordinarily understood. The general evidence indicates that the α and primary β particles are expelled from the nucleus, and not from the outer structure of the atom. If this be the case, the α particle which carries a positive charge would have its velocity increased in passing through the strong repulsive field surrounding the nucleus; on the other hand, the β particle which carries a negative charge must be retarded in its escape from the nucleus, and must possess great initial energy of motion to escape at all. There appears to be no doubt that the penetrating γ rays have their origin in some sort of disturbance in the rings of electrons nearest to the nucleus, but do not represent, as some have supposed, the vibrations of the nucleus itself.

α Rays.

A brief account was given of the recent work of Rutherford and Robinson in determining with accuracy the velocity of expulsion of the α particles from certain radio-active substances. This was done by measuring the deflection of a pencil of α rays in strong magnetic and electric fields. With the aid of intense sources of radiation, it was found that the value of E/M—the ratio of the charge carried by the α particle carried to its mass—was 4820 units, a value to be expected if helium has an atomic weight 4 and carries two unit charges. This experiment also shows that the mass of the flying positive particle is not affected appreciably by its swift motion. From known data the initial velocity of the expulsion of the α particles from all other radio-active substances can be deduced with accuracy.

If the expulsion of an α particle from an atom is the result of an internal explosion, we should anticipate, from the analogy of a shot from a gun, that the residual atom would recoil in a direction opposite to the escaping β particle. The existence of these "recoil" atoms can be shown in a variety of ways, for the velocity of recoil is sufficient to cause the atoms to leave the surface on which they are deposited and to pass through a considerable distance in air at a pressure of one millimetre before they are stopped. It is to be anticipated that the momentum of a recoiling atom should be equal and opposite to that of the escaping α particle. Since the deflection of a charged particle in motion in a magnetic field is inversely proportional to its momentum, the deflection of a stream of recoiling atoms should be the same as for the α particles if the atoms carry the same charge. Dr. Makower has examined the deflection of a pencil of recoil atoms in a magnetic field, and found it to be exactly half of that due to the α particle, proving definitely that the recoiling atom carries only one unit of positive charge in place of two for the α particle.

We thus see that the simple application of momentum enables us to deduce the mass and energy of the recoiling atoms. Since the mass of the radio-active atoms is about fifty times that of the α particle, the velocity, and also the energy, of recoil is only about 1/50th of that of the escaping α particle. In a similar way, it can be shown that the ejection of a swift β particle should cause a vigorous recoil of the atom, though not so marked as in the case of the more massive α particle.

β Rays.

During the last few years notable advances have been made in our knowledge of the mode of emission of β particles from radio-active atoms. The work of Baeyer, Hahn, and Meitner, and of Danysz, has shown that the β rays from a radio-active substance like radium B or radium C contain a number of definite groups of rays which are expelled with definite velocities. This is best shown photographically by examining the deflection of a pencil of β rays in a magnetic field. In a uniform field, each of the groups of rays describes a circular path the radius of which is inversely proportional to the momentum of the β particle. By the application of special methods it has been found possible to obtain a veritable spectrum of the β rays. The spectrum of the β rays from radium B and radium C has been very carefully examined by the writer and Mr. Robinson, and found to give a large number of well-marked bands, each of which represents a group of β rays, all of which are expelled with identical speed. It was at first thought that most of the energy of the β rays was comprised in these groups, as some of the bands on the photographic plate were very marked. Chadwick, however, has recently shown that the fraction of the rays which give a line spectrum is only a few per cent. of the total radiation. The general evidence shows that the β radiation from these substances gives a *continuous* spectrum due to β rays of all possible velocities, on which is superimposed a *line* spectrum due to a small number of β particles of definite velocity comprising each group.

Lines in the β-ray spectrum have been observed for particles which have a velocity not far from that of light, but the photographic effect of the particles becomes relatively feeble for such high speeds.

It is known from direct measurement that each atom of radium B or of radium C in its disintegration emits *on an average* one β particle. In the β-ray spectrum of radium C at least fifty definite bands are observed, differing widely in intensity. It is thus clear that a single atom in disintegrating cannot provide one β particle for *each* of these numerous groups. It is thus necessary to conclude that each atom does not emit an identical β radiation. The results are best explained by supposing that the β-ray spectrum is the statistical effect due to a large number of atoms, each of which may only give one or two of the groups in its disintegration. In this respect a β-ray transformation is distinguished from an α-ray transformation, for in the latter case each atom emits one α particle of characteristic speed. It will be seen later that there is undoubtedly a very close connection between the emission of β and γ rays from radio-active atoms, and the probable explanation of the remarkably complex β-ray spectrum will be discussed later.

With the exception of one element, radium E, and possibly uranium X, all the radio-active substances which emit primary β rays give a line spectrum. For the majority of elements the strong lines in the β-ray spectrum have been determined by Baeyer, Hahn, and Meitner, but more intense sources of radiation will be necessary to map accurately the weaker lines.

γ *Rays.*

The earlier experiments on the γ rays were mainly confined to a determination of the absorption of the more penetrating radiations by different kinds of matter. It was early observed, however, that some of the radiations appeared to be complex. This was shown by anomalies in the initial part of the absorption curve. In the meantime, a notable advance in our knowledge of X-rays had been made by the work of Barkla. He found that under certain conditions each element when bombarded by X-rays of suitable penetrating power gave rise to a strong radiation which was characteristic for that element, *e.g.*, the lighter elements from aluminium to silver emitted characteristic radiations called the "K" series, which increased rapidly in penetrating power with the atomic weight of the radiator. It was found that the heavier elements emitted in addition another characteristic radiation of softer type, which was called the "L" series. These results showed clearly that there must be definite structures within the atom which gave rise to a definite radiation under suitable conditions of excitation. From these results it seemed probable that the γ rays from radio-active matter must consist of the characteristic radiations of these heavy elements, analogous in type to the corresponding radiations observed in ordinary elements when excited by X-rays or kathode rays. These conclusions were confirmed by a series of investigations made by Rutherford and Richardson. The γ rays were analysed by means of their absorption by aluminium and by lead, the disturbing effects of the primary β rays being eliminated by means of a strong magnetic field. It was found, for example, that the γ rays from radium B, when examined by their absorption in aluminium, consisted of at least two types, one easily absorbed, and the other eighty times more penetrating. By further observations of the absorption of the γ rays by lead, Richardson found that the rays from radium B could be divided into at least four definite types, each of which was absorbed exponentially by lead. Similar results were obtained for all the radioactive elements which emitted γ rays. In some cases the soft γ rays, *e.g.*, those from radium B, corresponded to the characteristic radiation of the "L" series, and others to the "K" series. The general results, however, indicated that several additional series of characteristic radiations are present in some cases. It was clear from these experiments that the γ rays corresponded to the natural modes of vibration of the inner structure of the radio-active atoms. In the meantime the experiments of W. H. Bragg and W. L. Bragg, and of Moseley and Darwin, had shown that the characteristic X-radiations of the elements gave definite and well-marked line spectra. These spectra were simply determined by reflecting the rays from crystals. If this were the case, it seemed probable that the γ rays from the radio-active atoms would also give line spectra, and thus allow the natural frequencies of vibration of these atoms to be determined. During the past year, a number of experiments have been made to test this point by Rutherford and Andrade, using radium B and radium C as the source of γ radiation. As was anticipated, it was found that the γ rays from radium B and radium C gave well-marked line spectra. The general method employed was to use an α-ray tube containing a large quantity of emanation as a source of radiation. The γ rays were reflected from a crystal of rock salt, and the position of the spectrum lines determined photographically. Usually twenty-four hours were necessary to obtain a marked photographic effect. Special difficulties arose in these experiments which are absent in an investigation of a similar kind with X-rays. In addition to γ rays, the radio-active matter emits very penetrating β rays which have a strong photographic action; while the γ rays in their passage through matter themselves give rise to high-speed β rays. The disturbing effect of these radiations has to be eliminated by placing the whole apparatus between the poles of a powerful electromagnet. In this way it was found that the spectrum of radium B consisted of a large number of lines, of which the most intense were deflected at angles of $1^\circ\ 46'$, 10°, and 12°. The more penetrating radiation from radium C gave a strong line of 1° and a fainter line at $43'$. The strong lines at 10° and 12° are due to easily absorbed γ rays, and undoubtedly correspond to the "L" radiation of radium B. The line at 1° corresponds to a very penetrating radiation which has a wave-length less than 1/10th of an Angström unit. The penetrating γ rays from radium C have by far the shortest wavelength so far observed. It does not seem probable that such short waves can be produced artificially in an X-ray tube unless possibly an exceedingly high voltage be applied.

There is one interesting result of these investigations that should be mentioned. The two strong lines of the radium B spectrum deflected at 10° and 12° were found to correspond exactly in position to the X-ray spectrum of lead. These experiments thus confirmed the view based on chemical evidence that radium B and lead were isotopic, *i.e.*, they were elements of practically identical chemical and physical properties, although their atomic weight differed by seven units.

Connection between β *and* γ *Rays.*

Before considering in detail the difficult problem of the connection between β and γ rays, it is desirable to summarise the main facts that have been established in regard to the relations between kathode rays and X-rays :—

(1) A small part of the energy of kathode rays falling on a radiator is converted into X-rays, the average frequency of the latter increasing with the velocity of the kathode particle.

(2) X-rays in passing through matter give rise to a β radiation. The initial energy of the escape of the electrons increases with the frequency, and is probably proportional to it.

(3) Electrons or X-rays of appropriate energy are equally able to excite the characteristic radiations in an atom.

The results which have been shown to hold for the X-rays hold equally for the β and γ rays, which have much greater individual energies, *e.g.* Gray and Richardson have shown that the β rays from radio-active matter are able to excite the characteristic radiations of the elements in a number of substances, while γ rays in passing through matter give rise to high-speed electrons. It was long ago suggested by Bragg that β rays and X-rays are mutually convertible forms of energy, *e.g.* a β particle falling on matter may be converted into an X-ray of the same energy, and the latter in passing through matter may in turn be converted into an electron of identical energy. This assumes that the energy of an X-ray and an electron are mutually convertible, and the energy may appear under suitable conditions in either of the two forms. While the general evidence indicates that this point of view may hold closely for the conversion of the energy of a single X-ray into that of a swift electron, it is very doubtful whether it holds for the converse case of the excitation of an X-ray into an electron. We shall see later from experimental evidence that in general the energy of the electron required to excite an X-ray of definite frequency is always greater than the corresponding energy carried off in the form of an X-ray.

It was early observed that there appeared to be a close connection between the emission of β and γ rays from radio-active matter. In all cases, the two types of radiation appeared together. A closer examination, however, showed that there were very marked differences between the relative energies of the β and γ rays from different radio-active elements. For example, radium C emits intense β rays and also intense γ rays; on the other hand, radium E emits intense β rays over a wide range of velocity, but exceedingly weak γ rays. Differences of a similar kind were observed amongst a number of the radio-active elements. One striking distinction, however, was to be noted. All the radio-active substances which give a marked line spectrum of β rays also emitted intense γ rays. On the other hand, a substance like radium E, which gave scarcely any γ rays at all, gave a continuous spectrum of β rays in which no lines have so far been observed. It thus appeared probable that the line spectrum of the β rays was intimately connected with the emission of γ rays, and this conclusion has been completely established by recent experiments. As we have seen, γ rays in passing through matter give rise to high-speed β rays. Using radium B and radium C as a source of γ rays, the β radiation excited in a number of metals by the passage of γ rays was analysed in a magnetic field by Messrs. Robinson and Rawlinson and the writer, and was found to consist in part of definite groups of β rays. When lead was the absorbing material, the magnetic spectrum of the β rays excited by the γ rays was found to be nearly identical with the primary β-ray spectrum of radium B. This striking result shows that those β rays escaping from the radio-active atom which give rise to a line spectrum must result from the conversion of γ rays into β rays in the radio-active atom. The slight differences observed in the spectrum for different metals is probably connected with the energy required to excite one of the characteristic radiations of the element used as absorber.

An explanation of the marked differences in the character of the β and γ radiation from different radio-active atoms can, I think, be given on the following lines. Some of the γ rays are broken up in their escape from the atoms, and the energy of each converted γ ray is transferred to an electron which escapes with a definite velocity dependent on the frequency of the γ radiation. Taking into account a large collection of disintegrating atoms, each of the possible modes of characteristic vibration of the atom gives rise to an electron of definite speed. In this general way we may account for the line spectrum of the β rays which is so commonly observed. On this view, we should expect to obtain a well-marked line spectrum of β rays when a substance emits strong γ rays—a result in accord with observation.

In order to account for the marked differences in the types and intensity of γ rays from different radio-active substances, it seems necessary to suppose in addition that the primary β particle always escapes from the nucleus in a *fixed* direction with regard to the structure of the atoms under consideration. For example, we have already pointed out that radium E, although it emits intense β rays which give a continuous spectrum over a wide range of velocity, emits very weak γ rays. Since there can be no doubt that the β rays have sufficient speed to excite the characteristic modes of vibration which must be present in the atom, we are driven to the conclusion that the β particle escapes in such a direction that it does not pass through these vibrating centres. On this view, the type of characteristic γ rays which are excited, and consequently also the corresponding speed of the β rays which arise from the converted γ rays, will depend entirely on the direction of escape of the primary β particle. The definite direction of escape of the primary β particle, which varies for atoms of different substances, also suffices to explain a number of other differences observed in the mode of release of energy from various radio-active atoms. It is supported by many other observations which indicate that the atoms of a particular radio-active substance break up in an identical fashion.

We have so far considered only in a qualitative way the relation between the groups of rays in a β-ray spectrum and the emission of characteristic γ rays. During the last few years there has been a growing body of evidence that the energy E carried off in an X-ray of frequency ν is proportional to this frequency, and is given by $E = h\nu$ where h is Planck's fundamental constant. If the whole of the energy of an X-ray can be given directly to an electron, the energy communicated to the latter should be $h\nu$. There is no doubt that in many cases this simple relation holds very approximately, but the measurements so far available are not sufficiently precise to settle definitely whether a part of the energy may not appear in another form.

Assuming that the transfer of the energy from an X-ray to an electron is complete, we should expect to find groups of β rays of energy corresponding to $h\nu$ where ν is the frequency of the γ rays found experimentally. Such a relation is found to hold within the limit of experimental error for three marked groups of low velocity β rays emitted from radium B. On the other hand, it is found that many of the high-velocity groups of β rays from both radium B and radium C have energies many times greater than correspond to any observed frequency. Not the slightest evidence, however, has been obtained that corresponding high frequencies of vibration exist in the radio-active atom; in fact, all the evidence points to the fact that these high-speed electrons arise from one or more of the observed frequencies in the γ-ray spectrum.

In order to account for such results, it seems necessary to suppose that the γ rays of high frequency are not necessarily emitted as single pulses, but consist of a train of pulses either produced simultaneously or following one another at very short intervals. Each of these pulses has an energy $h\nu$ corresponding to the frequency ν, but the total energy in the train of waves is $ph\nu$ where p is a whole number, which may have possible integral values 0, 1, 2, 3, . . . etc., depending on the structure of the atom and the conditions of excitation. The penetrating power of such a train of waves corresponds to that of a single wave of frequency ν, but on passing through matter the energy of the whole train of p waves occasionally may be transferred to an electron which consequently is expelled with an energy $ph\nu$. There is very strong evidence of the general correctness of this point of view, for most of the stronger lines in the β-ray spectrum of radium C have energies which correspond to an *integral* multiple of the energy corresponding to the strong lines actually observed in the γ-ray spectrum It seems probable that under the ordinary conditions of excitation by kathode rays in a vacuum tube, the X-ray contains only one pulse or wave, but under the far more powerful stimulus of the very swift β particle escaping from the atom, a long train of waves, each of the same frequency, is produced. The energy of the whole train of waves may under suitable conditions be given to an electron, which consequently has a speed very much greater than that impressed upon it by a single wave of the same frequency.

Limit to the Frequency of Vibration of the Atom.

There is one question of fundamental importance which arises in considering the modes of vibration of the atom, viz. whether there is a definite limit to the frequency of the radiation which can be excited in a given atom. Theory does not provide us with an answer to this problem, since little is known about the conditions of excitation, nor even of the nature of such high-frequency vibrations. A study of the frequency of the γ rays from radio-active substances is of great importance, as it throws much light on this problem.

As we have seen, the energy of the β particle escaping from the nucleus of radium C is equivalent to that acquired by an electron moving in an exhausted space under a potential difference of several million volts. This high-speed electron passes through the electronic distribution in its escape from the atom. Notwithstanding such ideal conditions for the excitation of high-frequency radiations of the atom, the highest frequency in the radiation emitted by radium C is only about twice that obtainable from an ordinary hard X-ray tube excited by 100,000 volts. It thus appears probable that there is a definite limit to the frequency of the radiation obtainable from a given atom, however high the speed of the disturbing electron. This limiting frequency is determined not by the speed of the electron but by the actual structure of the atom. Since the γ radiation from radium C gives a line spectrum. it would appear that the highest frequency obtainable is due to a definite system of electrons which is set into characteristic vibration by the escape of a β particle. In order to throw further light on this point, Prof. Barnes, Mr. H. Richardson and myself have recently made experiments to determine the maximum frequency obtainable from an X-ray tube for different constant voltages. The Coolidge tube, which has recently been put on the market, is ideal for this purpose, as it provides powerful radiation at any desired voltage. The anti-kathode is of tungsten of atomic weight 184, so that we are dealing in this case with the possible modes of vibration of a heavy atom. The maximum frequency of the radiation was deduced by measuring the absorption by aluminium of the most penetrating rays emitted at different voltages. The absorption of X-rays of different frequencies by aluminium has been examined over a very wide range, and can be expressed by simple formula. It was found that for 20,000 volts the frequency of the radiation was slightly lower than that to be expected if Planck's relation held. With increasing voltage there is a rapid departure from Planck's relation. The frequency reaches a maximum at about 145,000 volts, and no increase was observable up to the maximum voltage employed, viz. 175,000 volts. The experiments thus show that the frequency of radiation reaches a definite maximum, which is no doubt dependent on the atomic weight of the particular radiator employed. It is of interest to note that the maximum penetrating power of the X-rays from the Coolidge tube in aluminium is about the same as the γ rays from radium B, but is about 3/10 of the γ rays from radium C. There is evidence which suggests that the very penetrating γ rays from radium C correspond to the octave of the "K" characteristic radiation of that element. If this be the case, it may prove possible that a still more penetrating radiation might be obtained from tungsten, but in order to excite it a voltage of the order of a million volts would probably be required. In any case, it seems clear that Planck's relation does not hold for excitation of high frequencies by swift electrons, but may hold very approximately for lower frequencies corresponding to the radiation excited by a few hundreds or thousands of volts. On the other hand, the evidence obtained from a study of the β rays excited by X-rays or γ rays certainly indicates that the relation $E = ph\nu$ holds at any rate very approximately for the highest frequency examined. It is thus obvious that the emission of β and γ rays from the radio-active atoms is clearly connected with the general theory of radiation, and it seems likely that a close study of these radiations will throw much light on the mechanism of radiation in general.

There can be little doubt that the penetrating γ rays from active matter have their origin in the vibration of electronic systems in the structure of the atom outside the nucleus. The nucleus itself, however, must be violently disturbed by the expulsion of an α or β particle. If this leads to the emission of a γ radiation, it must be of exceedingly high frequency, as the forces holding together the component parts of the nucleus must be exceedingly intense. We should anticipate that this radiation would be extraordinarily penetrating, and difficult to detect by electrical methods. So far no experimental evidence has been obtained of the existence of such very high frequency radiations, but it may be necessary to devise special methods before we can hope to do so.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Reference is made in the *Times* of June 25 to the large number of Cambridge men now on active service; from a "War List" which has just been issued it appears that 8885 members of the University are with the colours. The official list gives the names of those who have been killed or wounded in action, and it appears that for every four who have been wounded three have been killed. This is due to the fact that most of the Cambridge men serving are either 1st or 2nd lieutenants.

EDINBURGH.—Since the beginning of the war the Officers Training Corps of the University has supplied 686 commissioned officers: artillery, 234; infantry, 288; engineers, 79; medical corps, 85. In addition many others have been under training as the University Reserve. Both in the 15th Royal Scots and in the 14th Argyll and Sutherland Highlanders, a nucleus of a company has been formed by University students. During the summer term a large part of the engineering building and the neighbouring class-room of applied mathematics have been used by the School of Instruction for Commissioned Officers. Systematic courses are being given and are being attended by seventy-five infantry officers and twenty-four artillery officers. The hours are from 9 a.m. to 6 p.m., and each officer under instruction is expected to read for two or three hours every night. Qualifying examinations are held at the end of each month's instruction. The adjutant who has charge of the School of Instruction is Major Mackenzie, one of the University lecturers in chemistry, and one of the instructors is Lieut. Todd, lecturer in engineering. These facts will give some idea of the way in which Edinburgh University men are answering to the call.

GLASGOW.—The Senate has appointed Dr. S. Alexander, professor of philosophy in the University of Manchester, to the post of Gifford lecturer for the period 1916–18.

LONDON.—Mr. G. F. Goodchild, principal of the Wandsworth Technical Institute, has been appointed to the post of registrar of the Council for External Students, in succession to Mr. Alfred Milnes.

IT is announced in *Science* that by the will of Miss Helen Collamore, of Boston, 20,000*l.* is bequeathed to Simmons College, 4000*l.* to Radcliffe College, and 2000*l.* primarily to aid women students in post-graduate courses in the Massachusetts Institute of Technology.

To commemorate the services rendered to the Ocean Steamship Company, Ltd., by the two founders of the company, the late Mr. Alfred Holt and the late Mr. Philip Henry Holt, a sum of 20,000*l.* has been handed by the company to the Holt Education Trust, and the income is to be applied in perpetuity by the trustees for the purpose of higher education in Liverpool.

THE successful series of public lectures on the Empire, by Dr. H. B. Gray, the official lecturer, will be continued at the Imperial Institute throughout July. The lectures, which are now illustrated by lantern slides, are followed in each case by a visit to the exhibition galleries of the Imperial Institute, which afford a unique object-lesson in the Empire's commercial capacities. The lectures for July, which will be given on Wednesdays at 3 o'clock punctually, are as follows:—July 7, British West Africa; July 14, Fiji, Western Pacific, and Falkland Islands; July 21, Egypt and the Sudan. Admission is free by ticket, to be obtained at the central stand in the exhibition galleries, Imperial Institute, South Kensington, S.W.

THE recent report of the Board of Education (Cd. 7934) for the year 1913–14 remarks with regret that no improvement in the provision of higher technical instruction in day technical classes is shown in the figures relating to 1912–13. In that year twenty-six institutions provided technical institution courses, the total number of separate courses in these institutions being seventy-eight. Of these, nineteen were courses in preparation for matriculation or other examinations forming stages towards university degrees, fifty-four were technological courses in engineering, chemistry, and subjects connected with the building, mining, textile, and leather trades, many of which were also attended by some students preparing for degrees, and five were scientific courses mainly in provision for professional qualifications. The total number of students enrolled in the courses was 1464. The number of students taking the full courses was 1236, of whom 539 were in their first year, 374 in their second year, 269 in their third year, and fifty-four in later years of their courses. The number of day technical classes, as distinct from courses, recognised in 1912–13 was 281, and these were held in 110 institutions. The students in attendance numbered 12,970. Of the courses held, 131 were only part-time or short full-time courses. The other 150 were in the nature of full-time day schools. While the latter was approximately the same in number as in the previous year, there has been a fall of thirty-nine in the case of the part-time courses.

THE Professional Classes War Relief Council has issued a report of six months' work which shows not only the need that existed for such an organisation, but the variety of means that have been employed. The applications during the six months which ended on May 6 numbered 2000, and the number of cases dealt with is 1600. One hundred cases were referred to other societies. Among the most useful forms of assistance have been temporary employment, education and training, financial help and loans, medical help, and hospitality. The professions dealt with have included authors, analytical chemists, engineers, surveyors, and teachers. In the matter of education 1120*l.* has been expended. Through the generosity of head-masters and various governing bodies, 134 children who would otherwise have lost all education are becoming pupils at reduced fees, and in many cases the assistance given to pupils also enables schools to continue which would otherwise have been ruined. In addition to this thirty-three candidates are undergoing training in productive professions; four have already qualified and have obtained remunerative employment, and others are about to take up their work. The work of the council does not perhaps lend itself to picturesque description, but it is filling an important place in our present disturbed social conditions. The expenditure is now at the rate of 430*l.* per week, and unless a sum of 25,000*l.* can be raised in the next few months the work cannot be continued. No other body is doing exactly the same kind of work, in trying by co-ordination of existing benevolent funds, as well as by its own specialised forms of assistance, to tide over the professional classes who are so heavily penalised by the war. The offices of the council are 13 and 14 Prince's Gate, S.W.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 17.—Sir William Crookes, president, in the chair.—Dr. E. J. **Russell**: Soil protozoa and soil bacteria. In view of the claim recently made by Goodey that soil protozoa cannot function as a factor limiting the numbers of bacteria in soils, the author has brought together the evidence on which this view is based. It has been shown in numerous experiments that the numbers of bacteria in normal soils are relatively low, but they can be raised by any treatment that kills trophic forms and not spores. Starting, in the first instance, to find the properties of the factor which keeps down the bacterial numbers, and without framing any hypothesis as to its nature, these were found to be: (*a*) active, and not a lack of some essential; (*b*) not bacterial; (*c*) extinguished by heat or poisons, and after extinction does not reappear; (*d*) can be reintroduced by adding a little untreated soil; (*e*) is favoured by conditions favourable to trophic life in the soil. These properties indicate that the factor is biological. Search was therefore made for organisms fulfilling these conditions and numbers of protozoa were found. Definite evidence has been obtained that trophic forms occur as normal inhabitants of the soil, and the estimates of numbers so far available show that they are considerable. There is the closest possible relationship between the extinction of the protozoa and the extinction of the limiting factor, and also between the re-establishment of the protozoan fauna and the setting up of the limiting factor after reinfection with small quantities of soil.—Prof. W. M. **Hicks**: The enhanced series of lines in spectra of the alkaline earths. A discussion of the enhanced series of the alkaline earths is carried out in order to determine their relation to the sun. For this purpose the results given for Mg, Ca, Sr by Fowler in his recent Bakerian Lecture are used, and, in addition, the corresponding series in Ba and Ra are considered. It is found that the quantity Δ', giving the doublet separations, is given with great accuracy in terms of the oun, as follows:—Mg, $56\frac{1}{2}\delta$; Ca, 68δ; Sr, 58δ; Ba, $56\frac{1}{2}\delta$; Ra, $60\frac{1}{2}\delta$; where δ is four times the corresponding oun for the element. The satellite separations are also found as functions of the same quantity. Further it is shown that these series strongly support the general relations given in a former communication that the first p-sequence depends on a multiple of the atomic volume, and that the diffuse sequence is such that the denominators of the first lines, when the wave number is expressed in the form $A - N/(\text{den})^2$, are themselves multiples of Δ' or of the oun.—Prof. H. F. **Baker**: Certain linear differential equations of astronomical interest. This paper is written to exemplify the application of a general method for the solution of linear differential equations given by the author some years ago. The method furnishes solutions in a form valid for an indefinitely extended region. It is here applied (1) to establish a result as to the convergence of the solution of a particular equation, apparently in disagreement with a conclusion reached by Poincaré in his "Méthodes Nouvelles de la Mécanique Céleste"; (2) to place the general method given by Laplace for the absorption of the time in astronomical series under trigonometrical signs in connection with the ordinary theory of characteristic exponents; (3) to discuss in general terms the oscillations of a dynamical system about any given possible state of motion; (4) to furnish a regular calculus for the solution of the equation used by G. W. Hill for the motion of the moon's perigee, and similar equations. The earlier part of the paper discusses particular equations from a less formal point of view, and has seemed necessary in order to place the matter in proper light. One particular problem discussed is that of the stability of three bodies of any masses moving in ellipses at the angular points of an equilateral triangle, a matter of which the discussion has recently been revived.—Prof. Karl **Pearson**: The partial correlation-ratio. The general theory of mutiple correlation has been long established, and is summed up in the discussion of two constants—the partial correlation coefficient and the multiple correlation coefficient. If there be m variates, $1, 2, 3 \ldots m$, then the partial correlation coefficient of the $(m-2)^{\text{nd}}$ order is related to the multiple correlation coefficients of the $(m-1)^{\text{th}}$ and $(m-2)^{\text{nd}}$ orders by the equation:—

$$1 - {}_{34\cdots m}r^2_{12} = \frac{1 - R^2_{1\cdot 234\cdots m}}{1 - R^2_{1\cdot 34\cdots m}}.$$

The object of the present paper is to give the corresponding equation for skew-regression. It is known that the value of the above relation is exactly commensurate with the linearity of the regression, a condition not synonymous with but embracing as a special case gaussian or normal distributions of frequency. When the regression is not linear, nor the partial variations homoscedastic in distribution, then the statistician has to use, in order to represent by a single coefficient the association of two variables, the correlation-ratio, usually symbolised by η. The use of the correlation-ratio has been hampered by the absence of any generalised theory in the case of multiple variates. If ${}_{34\cdots m}\eta_{1\cdot 2}$ be the partial correlation-ratio of the first variate on the second for constant third, fourth ... m^{th} variates and $H_{1\cdot 23\cdots m}$ be the multiple correlation-ratio for 1 on $2, 3 \ldots m$, then the fundamental formula is—

$$1 - {}_{34\cdots m}\eta^2_{1\cdot 2} = \frac{1 - H^2_{1\cdot 234\cdots m}}{1 - H^2_{1\cdot 3\cdots m}}.$$

The paper shows that there are only three independent first order partial correlation-ratios and gives the formulæ for these, and for higher order correlation-ratios in terms of the multiple ratios and lower order partial ratios.—S. **Skinner** and F. **Entwistle**: The effect of temperature on the hissing of water when flowing through a constricted tube. The experiments deal with the temperature coefficient of the effect described by Osborne Reynolds before the British Association at Oxford, 1894. It is shown that the velocity at which hissing just occurs between 0° and 100° C. suffers a diminution which may be expressed by a formula $V_t = -c(t-\theta)$, where V_t is the velocity of the stream at a temperature t, and θ the critical temperature of water, and c a constant. It is argued that this result forms a measure of the tensile strength of the liquid, and consequently it brings the phenomenon of hissing into relation with the other properties of a liquid.—J. C. **McLennan** and J. P. **Henderson**: Ionisation potentials of mercury, cadmium, and zinc, and the single and many-lined spectra of these elements. (1) It is shown that a spectrum consisting of a single line is obtainable for mercury, for zinc, and for cadmium. (2) The wave-lengths of these lines are, for mercury, $\lambda = 2536{\cdot}72$ Å.U.; for zinc, $\lambda = 3075{\cdot}99$ Å.U.; and for cadmium, $\lambda = 3260{\cdot}17$ Å.U. (3) The minimum ionisation potentials for mercury, zinc, and cadmium are shown to be 4·9 volts, 3·74 volts, and 3·96 volts respectively. (4) Some considerations are presented which support Sir J. J. Thomson's theory of the two-type ionisation of atoms of mercury, and others which suggest that the theory is applicable as well to the ionisation of atoms of zinc and cadmium. (5) The minimum arcing potential differences which will bring out the many-lined spectra of mercury, zinc, and cadmium vapours are found to be 12·5 volts, 11·8 volts, and 15·3 volts respectively. These voltages are also probably the minimum ionisation potentials of the second type for the atoms of these three elements. (6) Considerations are presented which suggest the possibility of analysing the spectrum of an element in such a way as to enable one to correlate different portions of the spectrum with disturbances in definite portions of the atomic structure of that element.—Dr. A. E. H. **Tutton**: The monoclinic sulphates containing ammonium.—Completion of the double sulphate series. In this communication are described the five remaining double sulphates of the series $R_2M(SO_4)_2.6H_2O$, in which R is ammonium and M is nickel, cobalt, manganese, copper, and cadmium. The present memoir completes the author's work on the double sulphates of this series. The main conclusions are the following:—(1) These ammonium salts are truly isomorphous with the similarly constituted potassium, rubidium, and cæsium salts of the generic formula above given, but are not eutropic with them; the potassium, rubidium, and cæsium salts alone form the exclusive eutropic series in which the crystallographical properties (both morphological and physical) obey the law of progression with the atomic weight of the alkali metal which has been established in previous communications. This law is particularly well illustrated by the fact, to which no exceptions have been observed, that average change of angle between crystal faces, and also maximum change of interfacial angle (which exceeds two whole degrees), are directly proportional to change in atomic weight when any one alkali metal is replaced by another. (2) The dimensions of the space-lattice of any ammonium salt of the series are nearly identical with those of the intermediate rubidium salt, so that the two atoms of rubidium are replaced by the ten atoms of the $2NH_4$ radicle-groups without appreciably altering the crystallographic structural dimensions. (3) The salts of the series in which R is thallium (also studied in a previous memoir) resemble the ammonium salts closely, in truly belonging to the isomorphous series, but not to the more exclusive eutropic series formed by the salts of potassium, rubidium, and cæsium. Like the ammonium salts, they also closely resemble the rubidium salts, but the thallium salts are distinguished optically, possessing transcendent refractive power, both their refractive indices and their molecular refraction being far higher than for any other salts of the whole isomorphous series.—E. B. R. **Prideaux**: General equations for the neutralisation of dibasic acids, and their use to calculate the acidity of dilute carbonate solutions.—Prof. H. A. **Wilson**: The electrical conductivity and luminosity of flames containing salt vapours.—T. R. **Merton**: A spectrum associated with carbon in relation to the Wolf-Rayet stars.—Sir Wm. **Abney** and Prof. W. **Watson**: The threshold of vision for different coloured lights.—Lord **Rayleigh**: Hydrodynamical problems suggested by Pitot's tubes.—Prof. M. C. **Potter**: Electrical effects accompanying the decomposition of organic compounds. II.—Ionisation of the gases produced during fermentation.—Prof. E. W. **MacBride** and A. **Jackson**: The inheritance of colour in the stick-insect (*Carausius morosus*).—Sir Francis **Darwin**: The relation between transpiration and stomatal aperture.—D. M. S. **Watson**: The monotreme skull—a contribution to mammalian morphogenesis.

Mineralogical Society, June 15.—Dr. A. E. H. Tutton, president, in the chair.—G. M. **Davies**: Detrital andalusite in Cretaceous and Eocene sands. Detrital andalusite is not confined to Pliocene and later deposits as was formerly supposed, but is a frequent constituent throughout the Cretaceous and Eocene beds of the south-east of England. In the lower Cretaceous beds it is still perfectly fresh, and shows no signs of instability under the influence of meteoric water.—J. F. N. **Green**: The garnets and streaky rocks of the English Lake District. Certain peculiar rocks occurring in the Lake District are characterised by almandine garnets and parallel streaks of secondary minerals. The capricious distribution of the garnets in diverse rock-types was considered to exclude originality, and thermal or dynamic alterations were shown to be inadequate. Circulating solutions under pressure during the solfataric stage of the Borrowdale episode were suggested as the agent, and illustrations were given of the replacement of felspar by garnet in Lake District rocks. The same origin was assigned to the streaky infiltrations which frequently contain pyrites or garnet.—Dr. S. **Kôzu**: The errors in the angle of the optic axes resulting from those of the principal refraction indices determined by total reflection. The indices so found are correct within 0·0002 for sodium light. Assuming the error to be only half this, the extreme values of the angle are for anorthite, 76° 8·6′, and 79° 21·8′; for albite, 76° 14·1′ and 80° 46·9′; and adularia 56° 16·9 and 65° 56·9′.—Dr. S. **Kôzu**: The influence of temperature on the optic axial angle of sanidine from the Eifel. Pockels has shown that in those rhombic crystals in which the axial angle varies considerably in the neighbourhood of zero the relations between the angle and the temperature is represented by a parabola. Sanidine from the Eifel very nearly approaches the conditions of a rhombic crystal. The values of 2E were determined for seven different wave-lengths. The plotted curves were found to accord with Pockels's statement; further, the complex curves for the various wave-lengths were identical.—Dr. G. T. **Prior**: The meteoric stones of Warbreccan, Queensland. Three stones, weighing respectively about 69, 64, and 1 lb., were known to the natives of central Queensland before 1904, and their fall was probably seen. They were acquired by the British Museum in 1905. They are white-veined chondrites, and in chemical and mineral composition are similar to other members of the group.—A. F. **Hallimond**: Autunite. It is concluded that the Cornish material is essentially different from the Autun mineral, and the name bassetite is proposed for the former, the fundamental characters of which are:—Oblique, $\beta = 89° \ 17'$, $a : b : c = 0{\cdot}3473 : 1 : 0{\cdot}3456$; forms, 010, 110, 120, 011, 111, 121, $\bar{1}21$, $\bar{1}41$, $\bar{1}01$; twinning by parallel growth of a and c axes, perfect cleavage parallel to 010, also 100, 001; yellow, transparent; biaxial, 2E = 110°; pleochroic, pale to deep yellow; soluble in acids.

Linnean Society, June 17.—Prof. E. B. Poulton, president, in the chair.—The four following papers were reports on materials brought home by Prof. J. Stanley Gardiner from the expedition to the Indian Ocean in H.M.S. *Sealark* in 1905:—E. T. **Browne**: Medusæ from the Indian Ocean.—Prof. A. **Dendy**: (1) Report on the Hexactinellid sponges (Triaxonida); (2) Continuation (Tetraxonida).—J. C. **Robson**: The Cephalopoda obtained.

PARIS.

Academy of Sciences, June 21.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The extreme slowness of cooling in the deep parts of the earth's crust, and an attempt to estimate, starting from a certain period, the progress of the solidification.—Paul **Brück**: Observations of the Mellish comet (1915*a*) made at the Observatory of Besançon with the 33 cm. equatorial. Eleven positions of the comet are given for March 16, April 13, 15, 16, 17, May 14 and 15.—René **Garnier**: The representations of the integrals of the equations of M. Painlevé by means of the theory of linear equations.—M. de **Broglie**: The spectra of the homogeneous secondary X-rays. A claim for priority as regards a recent paper on the same subject by M. Glagolev.—E. **Raverot**: A temperature interval regarded in relation to mechanical measurements. Starting with the numerical coincidence that the erg is $0{\cdot}2381 \times 10^{-7}$ calories, and the specific heat of air at constant pressure is 0·2382 calories, the joule (0·238 cal.) is defined as the quantity of calorific energy corresponding to a variation of volume of the mass of 1 gram of air of 1/273 of its volume at 0° C., at the constant pressure of the atmosphere.—Léon **Bouthillon**: The charge of condensers by means of a constant electromotive force and their discharge in a spark circuit. Whatever may be the kind of spark-gap employed, the conditions under which a musical note is produced are the stable conditions under which the system is self-regulating.—G. A. Le Roy: The measurement of the waterproof qualities of cloths and military fabrics. The percolating water falls on a dry filter paper impregnated with a salt, and establishes an electrical circuit. The apparatus can be made recording, and does not require watching.—J. **Deprat**: The modifications in the structure of the Fusulinidæ from the Dinantian to the end of the Permian.—Pereira de **Sousa**: The earthquakes at Algarve (southern Portugal) from 1911 to 1914. These appear to be of epirogenic origin.—B. **Galitzine**: The earthquake of February 18, 1911. This earthquake coincided with a great rock slide at Sarez, in the Pamir, which filled up the valley of Mourgab and transformed it into a lake. The author concludes that this rock fall was not the consequence, but the cause of, the seismic disturbance registered at so many stations.—J. **Clarens**: The estimation of urinary acidity.—H. **Busquet**: The mode of action of colloidal gold: the production of cardiac effects by particles of metal not in solution. From a study of the effects of the injection of colloidal gold into the dog and rabbit, it is concluded that the immediate effects on the heart cannot be attributed to gold in solution, but must be produced by the suspended colloidal particles.—H. **Stassano**: The sterilisation of microbial cultures or emulsions by heat in thin layers.—Em. **Bourquelot**, M. **Bridel**, and A. **Aubry**: Researches on the glucosidification of glycerol by β-glucosidose (emulsin). The product obtained by the biochemical synthesis contained two glucosides, differing in their rotatory power and resistance to the action of emulsine.

BOOKS RECEIVED.

Lessons and Experiments on Scientific Hygiene and Temperance for Elementary School Children. By H. Coomber. Pp. xx+163. (London: Macmillan and Co., Ltd.) 1*s.* net.

Indian Mathematics. By G. R. Kaye. Pp. 73 (Calcutta and Simla: Thacker, Spink and Co.)

Numerical Examples in Physics. By H. S. Jones. Pp. xii+332. (London: G. Bell and Sons, Ltd.) 3*s.* 6*d.*

Citrus Fruits. By Dr. J. E. Coit. Pp. xx+520. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

The Principles of Rural Credits as Applied in Europe and as Suggested for America. By J. B. Morman. Pp. xviii+296. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

The Mutation Factor in Evolution, with Particular Reference to Œnothera. By Dr. R. R. Gates. Pp. xiv+353. (London: Macmillan and Co., Ltd.) 10*s.* net.

Plant-Life. By C. A. Hall. Pp. xi+380. (London: A. and C. Black, Ltd.) 20*s.* net.

The Analysis of Dyestuffs and their Identification in Dyed and Coloured Materials, Lake-Pigments, Foodstuffs, etc. By Prof. A. G. Green. Pp. ix+144. (London: C. Griffin and Co., Ltd.) 8*s.* 6*d.* net.

The Aeroplane. By A. Fage. Pp. viii+136. (London: C. Griffin and Co., Ltd.) 6*s.* net.

Aero Engines. By G. A. Burls. Pp. x+196. (London: C. Griffin and Co., Ltd.) 8*s.* 6*d.* net.

Laboratory Work for Coal-Mining Students. By J. Sim and A. M. Wylie. Pp. viii+136. (London: E. Arnold.) 2*s.* 6*d.* net.

Meteorology of Australia. Commonwealth Bureau of Meteorology. Results of Rainfall Observations made in Queensland, including all Available Annual Rainfall Totals from 1040 Stations for all Years of Record up to 1913, together with Maps and Diagrams. Pp. 285. (Melbourne: A. J. Mullett.) 10*s.* 6*d.*

Staffordshire. By W. B. Smith. Pp. xi+155. (Cambridge: At the University Press.) 1*s.* 6*d.* net.

The Strength of Materials. By E. S. Andrews. Pp. x+604. (London: Chapman and Hall, Ltd.) 10*s.* 6*d.* net.

Climbing Plants. By W. Watson. Pp. x+132+plates. (London and Edinburgh: T. C. and E. C. Jack.) 2*s.* 6*d.* net.

The Analysis of Non-Ferrous Alloys. By F. Ibbotson and L. Aitchison. Pp. vii+230. (London: Longmans and Co.) 7*s.* 6*d.* net.

Bartholomew's New War Map of Italy and the Balkan States. (Edinburgh: J. Bartholomew and Co.) 1*s.* net.

The Poison War. By A. A. Roberts. Pp. 144. (London: W. Heinemann.) 5*s.* net.

DIARY OF SOCIETIES.

FRIDAY, JULY 2.

GEOLOGISTS' ASSOCIATION, at 8.—A Provisional Hypothesis to Explain the Occurrence of the Various Types of Fossil Man: Prof. A. Keith.

SATURDAY, JULY 3.

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

MONDAY, JULY 5.

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

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THURSDAY, JULY 8, 1915.

EMMA DARWIN AND HER CIRCLE.

Emma Darwin: A Century of Family Letters, 1792–1896. Edited by her daughter Henrietta Litchfield. Vol. i., pp. xxxi+289. Vol. ii., pp. xxv+326. (London: John Murray, 1915.) Price 21s. net. Two vols.

CURIOSITY as to the intimate life of those who have become distinguished is at any rate human. It may be that in some cases it would be better if the veil were not withdrawn. But there is a better reason by which such curiosity is justified. We want to know what were the conditions under which great personalities have been produced. These remarkable volumes will charm by their literary merit. But here they invite considerations of a more scientific kind.

They give the history of three notable families which intermarried until they formed a sort of clan. The Allens were landed gentry of north of Ireland origin but settled in Wales; the Wedgwoods in Staffordshire and the Darwins in Lincolnshire were yeomen who rose in social rank, itself a note of racial ability. The relationships would be perplexing but for the pedigrees. All three strains were united when Charles Darwin married his cousin Emma Wedgwood.

The men had plenty of fibre, sometimes a little too fibrous, the women no less charm and vivacity. John Allen had nine daughters; the eldest married the second Josiah Wedgwood; one Sir James Mackintosh, whom Darwin thought an even better talker than either Carlyle, Macaulay, or Huxley, but whose misfortune was never to have red tape to tie up his bills; another was grandmother to Georgiana, Lady Salisbury; and still another was the wife of Sismondi, the historian. All families were well-to-do and "middle-class." But what a class it was; there was nothing like it at the time except the aristocracy at Geneva, with whom it was in touch through Sismondi and Madame de Staël. When Darwin married, a friend wrote: "It is very like a marriage of Jane Austen's, can I say more?" He could not, for the entire atmosphere was that of Jane Austen, wholesome, vivacious, intelligent. One of the Allen daughters made a penetrating remark *à propos* of an incident at Sydney Smith's: "In the gay world they commit more offences against the decencies of society than in the middle classes."

But though well-to-do the middle class of the early nineteenth century was simple and unaffected in its mode of life and content with intellectual pleasures. With leisure and freedom from anxiety it could turn to science and recruited the Royal Society. This swept that body into the social life of the day, which is now inevitably ebbing away from it. Darwin speculates in a letter to a son as to "what makes a man a discoverer of undiscovered things," and remarks that "many men who are very clever—much cleverer than the discoverers—never originate anything." He conjectures that "the art consists in habitually searching for the causes and meaning of everything that occurs." Perhaps the explanation lies in the difference between the inductive and deductive temperament. Hereditary aptitude must also count for something. The clan was clever enough but never failed to throw up originality. Tom Wedgwood was "the first discoverer of photography," Hensleigh was a mathematician and philologist, John with Sir Joseph Banks founded the Horticultural Society at Hatchard's shop, Sir Henry Holland and the Galtons were cousins. The amateur has been the glory of English science; there is now little place for him. The ground to be traversed before the fighting line is reached is too vast, and each worker must be content to "nibble" at his own little section with small knowledge of what the rest are doing. And so, rather unkindly, Prof. Armstrong describes the Royal Society as a "rabble." Science must now be content to be professional, if not professorial. In the last century it was not so. Leading men of science were in touch with one another and the larger life and influenced it. It seems strange to read that in 1842 at the Athenæum "they have *soirées* every Monday evening, and as all the literary and scientific men in London are in the club, they must be very pleasant."

In the second volume Mrs. Litchfield has given a picture of her mother which is a worthy complement to that her brother has given us of their father. Maria Edgeworth describes her "radiantly cheerful countenance, even now, debarred from all London gaieties and all gaiety but that of her own mind by close attendance on her sick husband." And the resources of that mind fill one with admiration. Some things are told almost too sacred for publication, yet one is glad to have known them. Two letters which she wrote to her husband on religion could not be surpassed for courage and affection. Darwin wrote on the last, "God bless you." Her literary judgment was admirably sound. Of course she knew Jane Austen by heart and could give off-hand the christian name of Mr. Woodhouse, asked in an examination paper, the point being that it can be inferred though never stated.

All sorts of celebrities flash through the pages,

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and there are plenty of thumb-nail sketches of them. It is interesting to know that Robert Brown, whom Humboldt calls "the glory of Great Britain," was shy and a dead weight at a dinner party, as it explains why he was thought morose. This was not Humboldt's fault, as at a breakfast at Murchison's he "talked without any sort of stop for three hours." Carlyle "is very pleasant to talk to, he is so very natural"; he said Cardinal Newman "has no occiput," and Woolner seems to have found it was more than a metaphor. It is difficult to resist quotation. But the opinion of Sir Francis Galton cannot be omitted, "that truth or falsehood in a nation is merely a question of geography, and that the nations who have not got the article do pretty well without it."

COLLOID CHEMISTRY.

The Chemistry of Colloids and some Technical Applications. By Dr. W. W. Taylor. Pp. viii+328. (London: Edward Arnold, 1915.) Price 7*s.* 6*d.* net.

THIS work can claim to meet a long-felt want with more justice than the majority of publications heralded by that familiar phrase. Until its appearance it has been necessary to refer students to German text-books, many of which are extremely difficult reading for even fair scholars of that language, while most of them devote considerable space to the discussion of theories of the soundness of which the beginner cannot be, and should not be tempted to imagine himself, a judge.

It is one of the merits of the present text-book that by far its larger portion consists of a lucid and concise account of observed facts, the description of which precedes the discussion of theories advanced to explain them everywhere but in the section dealing with adsorption, where the reversal of this order is undoubtedly the only pedagogically sound procedure. The text is divided into four parts: general properties of colloids; methods of preparation; adsorption and applications of colloid chemistry. The subjects indicated by these headings are treated clearly and adequately, the instructions for experimental work being particularly satisfactory—with the exception, perhaps, of ultra-microscopy. This is a point which always presents difficulty, as a knowledge of the principles of high-power microscopy must be presumed which is by no means general. As regards theory, the reviewer has been particularly struck with the very lucid summary of von Weimarn's theory of dispersoid formation, which gives the student all that is essential, while saving him the labour of wrestling with the extraordinarily difficult style of the original.

The chapters on adsorption generally follow Freundlich, but include some recent and important work on the behaviour of sols in contact with other liquid phases. A very necessary warning against identifying phenomena only superficially similar with adsorption, and against using the latter as a facile explanation of obscure processes, is sounded repeatedly. In the concluding section the application of colloidal chemistry to the explanation of various phenomena is illustrated by a number of examples selected at random and including the unavoidable dyeing and tanning. Here, also, the author is careful not to countenance any extravagant claims on behalf of the science, and the student will be left under the correct and stimulating impression that colloidal chemistry can show—in the words of the famous epitaph—"great achievement but still greater promise."

The book is well printed and adequately illustrated, and may be unreservedly recommended to all students desirous of a sound knowledge of what is probably the most widely important, and certainly the most fascinating, branch of physical chemistry.

GEOGRAPHY AS A SCIENCE.

The Teaching of Geography. By B. C. Wallis. Pp. viii+221. (Cambridge: At the University Press, 1915.) Price 3*s.* 6*d.* net.

PERHAPS no school subject, in recent years, has been so much discussed as that of geography. The old meaningless lists of names of places, "famous for" all kinds of curious, as well as important things, has been ruthlessly consigned to the scrap heap. Exactly what is to take its place no one has yet determined, and each expert goes his own way and proclaims his own gospel. Geography—economical, physical, regional, historical, practical—has annexed so many other domains of learning, that the specialists differ within very wide limits, and the non-specialist teachers are overwhelmed by conflicting claims, arguments, and interests.

This book, by Mr. B. C. Wallis, covers most of the questions that interest the practical teacher, and on each and all of them he has much to say that is valuable. He is a teacher himself, that is, a teacher of children; some of the people who theorise upon the subject are only teachers of adults.

Mr. Wallis would have us divide our school schemes of work into three sections—descriptive in the early stages; transitional for the intermediate stages; systematic and argumentative in the later stages. The descriptive stage includes story-telling, the awakening of the child's imagination and interest, and the introduction of simple map and out-of-door work. In the transition stage, the pupil is chiefly concerned with the investigation of *geographical principles* rather than with the acquisition of geographical facts. In the final stage, the pupil has to collect his own data, to construct his own maps and diagrams, and to reason out his own conclusions, that is, he has to learn the methods and principles of *geographical argument*. Most teachers will agree with these divisions, and be prepared to follow Mr. Wallis in his treatment of the first and second stages; the ideas and methods of the third stage are more debatable, but, from the author's point of view, they are well stated and reasoned.

It is difficult, in a short space, to mention even a fraction of the valuable things the book contains. There are practical exercises for in and out of doors; plans and suggestions for the ideal geography-room and for apparatus; arguments on the relation between geography and history and other subjects, with sensible ideas on correlation; and there are even a few lessons for examiners on how to set examination questions.

Everywhere full details are given in a style attractive, lucid, and often of considerable literary merit. In many places there is geographical information of great value, information such as a teacher cannot always find in the text-books at his disposal.

Full approval may be given to the recommendations to teachers of geography to avoid straying into attractive historical or geological byways, interesting as they may be, for they are not geography, and there is plenty of work to be done without going out of the proper field. It is wise, also, to insist that the geography teacher is not to wait for the science master to explain the working of a barometer before the results of reading the barometer are utilised, nor to waste his own precious time in explaining what falls within the province of another. Sometimes the academic treatment of a subject has to give way to a common-sense one, but it is not every author who writes a book who is willing to state this truth.

We commend the book to all teachers of geography, because it is so eminently sensible, practical, and stimulating. They need not adopt all the conclusions of Mr. Wallis, but they will find it difficult to disprove their truth, or to resist their attractiveness.

MUSICAL FORM AND DEVELOPMENT.

The Musical Faculty: Its Origins and Processes. By W. Wallace. Pp. vi+228. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

THE systematic and scientific study of the psychological processes involved in the creation and production of music is, from the nature of the case, exceedingly difficult, and the author is fully justified in claiming that there is room for further literature on the subject. How far he has been successful in dealing with these problems in the present book is open to some doubt.

Speaking generally, the first four chapters deal mainly with the development of music pure and simple, the remainder with musicians and their characteristics. Now in treating of individuals, there is no lack of statistical and historical evidence on which to base conclusions. Whether the subject-matter be the existence of musical prodigies, the part played by heredity, the influence on health, both mental and physical, of great musical genius, or such functional characters as mental audition, tonal memory, sense of tempo, power of detecting differences of tone quality, inhibition of sound perception, the data from which inferences may be drawn are of a fairly definite character, and, on the whole, Mr. Wallace's treatment may be regarded as satisfactory. But the present reviewer totally disagrees with what he says about music itself in the chapters entitled "A Readjustment of Values," "Historical Bearings," and "Individual Development."

Mr. Wallace may prefer modern French cacophonies to Haydn's and Mozart's delightful quartets and symphonies, but he surely cannot seriously wish us to believe that those early composers were lacking in originality or individuality simply because they could obtain what they wanted with the use of simple chords and melodies. Neither can we agree with the statement that "Music, as we understand it, has not yet established her eternal verities," and when he states that "it would be no feat for a composer to write another *Orfeo* to-day," we can only say we should like to see anyone try to do it!

Admittedly, both the character of musical form and the recognised standard of excellence are changing, and the changes are the result of a process of evolution similar to that which exists everywhere else. But evolution does not always represent a change to a higher standard of perfection. It sometimes stands for degeneration, and "a readjustment of values" may spell barbarism, as is evidenced in the use of poisonous gases in war and the massacre of women and children. We would rather suggest that musical art possesses an element of *permanence* which is not to be found in the other arts. The collection of masterpieces which the present generation has inherited from the classical composers is so large that a modern composer, working on the same lines, would find it next to impossible to assert his influence. Consequently, musicians have had to seek fresh fields and pastures new by tearing up the "scraps of paper" which their predecessors regarded as binding.

OUR BOOKSHELF.

Surface Tension and Surface Energy and Their Influence on Chemical Phenomena. By Dr. R. S. Willows and E. Hatschek. Pp. viii + 80. (London: J. and A. Churchill, 1915.) Price *2s. 6d.* net.

THE appearance of this book, following close on that of a similar work by Michaelis, is a welcome sign of the increasing interest now taken in this subject. The distribution of matter and energy at any interface, although of the first importance, has only come into prominence since the development of colloid chemistry.

The scope and character of the book may be indicated by a reference to the chief subjects discussed. They are:—the fundamental ideas of surface tension; intrinsic pressure; Gibbs's surface excess formula; recent experimental work on interfacial concentrations; electrical phenomena at interfaces, with special attention to the Lippmann electrometer and the dropping electrode; and, in conclusion, such matters as condensation on gas ions, effect of electrification on the vapour pressure of drops, and "waterfall electricity."

It is scarcely surprising that the authors have found it no easy task to co-ordinate these varied subjects; and to this difficulty is doubtless due a want of clearness in a few places. There is one notable omission; one would have expected to find the development of the surface excess equation, either as given by Gibbs himself, or by Thomson or Milner. Curiously, no mention is made of Milner's experimental work, the first attempt to test the formula.

In spite of these defects, the work must prove helpful to advanced students and research workers, biological and technical, who have a practical interest in adsorption and allied phenomena. There is a useful index, but it seems a pity that no references to original papers are given. W. W. T.

Fire Tests with Glass. "Red Books," Nos. 196 and 197. (London: British Fire Prevention Committee.) Price *2s. 6d.* each.

THESE two small books embody the British Fire Prevention Committee's Report on Fire Tests made respectively with skylight openings and windows filled in with "wired glass" manufactured in our own country. The skylights were five in number, each 2 ft. square, and arranged horizontally in a single straight row. The glazing was subjected to fire for an hour, followed by water from a steam fire-engine applied at close range for two minutes on the fire side. No fire passed through the glazing, but more or less water found its way through three of the five. Details of the tests are given, with illustrations showing the effects of the fire. The three vertical windows were subjected to a precisely similar test with much the same results. In the case of two of the windows neither fire nor water passed through the glazing, but in the third, though no fire passed through, the application of water caused perforation and some water got through. The temperatures reached before the application of water were not less than 1500° F. (or 815·5° C.). The maximum size of the vertical glazing tested was four feet by one foot.

The results of the tests clearly indicate that British wired glazing, when suitably fixed, can effectually check the spread of fire in a manner comparable with fire-resisting partitions and doors of much greater thickness and weight. The subject is well worth the serious attention of those interested in the limitation of damage by fire, especially in cases where the admission of light is desirable. J. A. A.

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 Okapi.

IN my letter published in NATURE of May 27 (vol. xcv., p. 342) dealing mainly with the "Supposed Horn-Sheaths of an Okapi," I stated that "it is only when extremely young that the backward slope of the back is very noticeable." It is perhaps the only statement I have made regarding the okapi which was not based on my own observations, and it appears to be erroneous. The impression was derived from a photograph reproduced in M. Fraipont's "Monograph on the Okapi," of a very young one captured by natives and brought into one of the Uele stations. I have since seen a photograph of the same animal from another source which shows that there was very little backward slope. At maturity the height of the okapi at the shoulders is only 2 to 3 in. at the most more than that above the hindquarters. The following measurements taken from three animals lying as they fell, one by Mr. A. E. H. Reid, and two by myself, bring this out quite clearly:—

	Young male (No. 507) ft.	in.	Old female (No. 686) ft.	in.	Old male (Reid's) (No. 717) ft.	in.
Nose to tip of tail (without hair)	6	$1\frac{1}{2}$	8	2	7	11
Tail (without hair)	0	14	0	14	0	14
Height at shoulder	4	$4\frac{1}{4}$	5	$1\frac{1}{2}$	4	$11\frac{1}{2}$
Height above hind quarters	4	2	4	$11\frac{1}{2}$	4	9
Excess of height at the shoulders	0	$2\frac{1}{4}$	0	2	0	$2\frac{1}{2}$

Mr. Reid has given me the following additional measurements for his specimen :—Girth of neck in front of shoulders 2 ft. 11½ in., and girth of chest behind shoulders 5 ft. 7 in.

The okapi has no "hump" at the withers, as might be supposed by the length of the spinous processes of the dorsal vertebræ and as represented in many mounted specimens. The back is as straight as that of any horse or antelope. The neck is deep at the base and tapers to comparatively small dimensions immediately behind the head without any curve. The body is rotund, and the limbs remarkably clean and sleek. The animal as I have seen it has distinctly graceful proportions, and does not give one the impression of being all angles as in the giraffe. When standing on the alert it holds the neck fairly high, slightly above the line of the back, with the head poised at an angle, and the ears well forward.

The animal is probably a surviving primitive form of a family closely allied to the ancestors of the giraffes, which, as the forest once covering all tropical and probably most of subtropical Africa gradually disappeared by the agency of man, have become modified, bulkier animals under the influence of sunlight and freedom in the open scrub country, where to browse on the young shoots of the thorny acacia trees, grown tall and table-topped owing to annually recurring grass fires, has necessitated the development of a longer neck.

The giraffe, now restricted to Africa, at one time, during the latter portion of the Tertiary period, I think, roamed far and wide over southern Europe and throughout a large extent of Asia. Similarly the okapi's area of distribution before the destruction of the forest was probably much wider than at present. There is, in fact, evidence that it inhabited the once forest-covered regions of the Upper Nile Valley. It was pointed out in 1902 that among the twelfth-dynasty paintings from Beni-Hasan, Egypt, there exists a picture, long known to archæologists, which portrays a creature termed "Sche," said to have a resemblance to the present-day okapi, except that the upper lip is somewhat protruded and proboscis-like, and there are no zebra-like markings, the body and limbs being of a uniformly reddish colour. It is possible that this picture represents a form of the okapi known to the ancient Egyptians. C. CHRISTY.

July 5.

Testing Respirators.

THE chief difficulty in the determination of the relative efficiency of these safeguards which are so freely offered to the public, and also utilised for the purposes of war, is the want of a standard method of testing the same.

As the result of a few preliminary experiments, I would suggest in the testing of different fabrics impregnated with chemical substances that the conditions of working must be standardised, and the following conditions met. A suitable container for the mixture of air and the poisonous gas is required, and this must lead directly to the surface of the fabric which is exposed to the action of the mixed gases as they pass through its substance.

The rate of flow of the gas through the cloth must slightly exceed that of the inflow of air under actual breathing conditions, and this must be standardised. The reduction in the amount of the added gas is observed by actual analysis, and the test only made after the air has been passing for a stated period, which must not be less than five minutes. The composition of the air being tested must correspond with that likely to be met with in practice. In the case of chlorine the reduction in the amount present in the air passing the treated screen can be easily observed by actual estimation. As so much depends upon the amount of moisture present on the screen, this should be also standardised. It may be contained in the gas as it passes the screen, which must be of constant area.

It is only possible by such means to study the effect of varying moisture on the rate of absorption, etc., and to set up standard conditions which will enable comparative results to be obtained.

I hope soon to be able to suggest what these standard conditions should be, and the best type of apparatus necessary to carry out comparative experiments. W. P. DREAPER.

London, E.C., July 5.

Photograph of Mellish's Comet.

I ENCLOSE herewith a contact print from a negative of comet Mellish obtained with the Franklin Adams star camera of the Union Observatory on June 6, 1915, with an exposure of ninety minutes. The position of the comet was then R.A. 22h. 35m., declination 70° 18′ south.

Comet Mellish, June 6, 1915. Exposure, 90m.

The proximity of the comet to the pole is well shown, even over the small region of the photograph, by the change in the direction of the star trails.

H. E. WOOD
(Chief Assistant).

Union Observatory, Johannesburg, June 10.

Bird Migration.

A SMALL item which may be of interest to those watching bird migration was noted on a recent voyage to America.

On s.s. *St. Louis*, of the American Line, about 6.45 p.m. (ship time) on May 3 a swallow came on board, evidently very tired, white breast feathers rather dirty, and, settling down, was caught by one of the passengers. It took some water but died during the night. There was no identification band on either leg.

The point of interest is that the ship was then about $49\frac{3}{4}°$ N. lat. and $23\frac{3}{4}°$ W. long., which would put her some 560 miles west of Cape Clear—about W. by S.—and some 680 miles N.W. from Cape Finisterre. The wind had been fairly steady from E.S.E. for the previous thirty hours, blowing 20–30 miles an hour.

The first swallows had been noticed at the place where I now am on Saturday, May 1, and no doubt the bird which reached the *St. Louis* had got separated from the general migration.

The bird seemed in fairly good condition, its brown throat and indigo head were sleek and glossy; the soiled breast feathers may have been due to the steamer's smoke as the bird came in from the lee side.

ED. WILDING.

Dunedin, Jordanstown, Co. Antrim, June 23.

Mercury Ripples showing Interference.

THE accompanying print of a photograph of mercury ripples showing interference, made in this laboratory, exhibits singularly well the circular waves from the two sources as well as the interference pattern produced. The two points of disturbance are maintained

by a forked pointer attached to the prong of a fork of frequency 50. With daylight illumination from a window, and a rotating sector to render the effect stroboscopic, a good natural picture of the surface is obtained.

S. G. STARLING.

Physical Laboratory, Municipal Technical Institute, West Ham, E.

Man's True Thermal Environment.

I FULLY agree with Mr. Grabham (NATURE, June 24, p. 451) as to the unsuitability of the constant-*temperature* (37° C.) psuchrainometer for many parts of the earth's surface. It is for this very reason, combined with the advantage of its much greater simplicity, that I am experimenting with the constant-*energy* form of instrument mentioned at the end of my former letter (NATURE, May 6, p. 260).

The effect of moisture can be brought into play with any type of psuchrainometer by providing its exposed surface with a water-wetted muslin cover, and no doubt in this condition the apparatus approximates more closely to the human body.

My interest in the matter, however, is physical rather than physiological. My immediate aim is to study the extent to which "atmospheric cooling" can be predicted from the readings of the existing meteorological instruments. It seems best, therefore, to begin with the simplest case of cooling, namely, that which is free from the thermal complications accompanying evaporation.

JAMES ROBERT MILNE.

Physical Laboratory, University of Edinburgh, July 1.

HIGH EXPLOSIVES.

MR. LLOYD GEORGE'S recent speech in the House of Commons, as Minister of Munitions, emphasised the very important part played by high explosives in the present war. It is essential at the outset to distinguish clearly between a propellent charge, which forces the projectile or shell through the bore of the gun, and the high explosive charge filling the shell itself and causing it to burst, through the intervention of a time or percussion fuse. Modern military propellants consist of gelatinised guncotton (nitro-cellulose), either alone or mixed with varying proportions of nitro-glycerine, pressed into any required shape. The finished explosive is of a colloidal, horny nature, and a piece of it held in the fingers, whilst burning, can be blown out quite easily. A charge lit in the enclosed space of the chamber of a gun can discharge a projectile with a velocity of about 1000 yards per second, developing in the chamber a pressure of, perhaps, twenty tons on the square inch. If the same quantity of the *ungelatinised* material were ignited in the gun-chamber it would detonate and blow the gun to pieces.

There is thus a wide difference between the effects produced by the burning of a propellant in the open, and in the chamber of the gun. In the latter case, before the projectile begins to move, the gases evolved produce pressure in the chamber, thus greatly accelerating the velocity of the explosive reaction.

The forces at work in the gun, however, are insignificant in comparison with those brought into play when a high explosive detonates. Even in the open, without any containing envelope other than a thin cylinder of paper, the writer has obtained with a high explosive a velocity of detonation of the explosion wave of some seven miles per second. When the high explosive is in an enclosed space, such as a shell, the velocity of the detonation wave is greatly accelerated, and in an almost infinitesimal period of time the explosive is converted into gases. The volume of gases produced varies according to the nature of the explosive, but, generally, for those used in shells, it may be taken that, at the temperature of explosion, the volume of gas evolved occupies from 15,000 to 20,000 times the volume of the original explosive. This is the reason for the enormous destructive and shattering effect of a high explosive.

The nitro-glycerine high explosives used in mining are unsuitable for shell filling, owing to the sensitiveness of nitro-glycerine to shock, which would cause premature detonation in the bore of the gun. The ammonium nitrate group of high explosives, also used in mining, which contain nitro-hydrocarbons, and in some instances aluminium, have been advantageously adapted for shells. Although the hygroscopic nature of ammonium nitrate is detrimental, this may be successfully overcome.

Abel, in 1865, first proposed the use in mines of compressed wet gun-cotton fired by means of a dry gun-cotton primer; this was later used for filling torpedoes, but it has the disadvantage of low charge density. Gun-cotton cannot be compressed to a greater density than 1·25. In other words, a torpedo head which would hold 125 lb. of compressed gun-cotton could hold from 160 to 180 lb. of the denser trinitrotoluene or picric acid, with a corresponding increase of destructive power.

Sprengel, in 1875, first showed that picric acid could be detonated, and in 1881, Turpin, in France, demonstrated the practical possibility of using it for filling shells. The idea was rapidly taken up by other countries.

The methods of manufacturing nitro-hydrocarbons suitable for shell filling are very similar to those in use for producing nitro-glycerine. A mixture of sulphuric acid and nitric acid is used, and large quantities, very frequently as much as a ton or even more, are made in one operation. To obtain the highest yields of pure products very great attention must be paid to the composition of the acids, to the efficiency of agitation, and to the temperature, which is regulated by internal heating or cooling coils.

Picric acid, discovered in 1771 by Woulfe, of London, when used for filling shells has a different name in each country. It is called Mélinite in France, Lyddite in England, Pertite in Italy, Shimose powder in Japan, Granatfüllung 88 in Germany, and Ecrasite in Austria. It is not always employed in the pure state, there being occasional addition of crésylite (trinitrocresol) or a salt of that substance, the object of which is to reduce the temperature of fusion. It is manufactured from phenol (carbolic acid, obtained from the distillation of coal-tar) by first dissolving in sulphuric acid and then treating the resulting phenol-sulphonic acid with nitric acid in excess. It forms yellow crystals with an intensely bitter taste. It has a specific gravity of 1·777 and melts at 122·5° C. Picric acid, if heated gradually, takes fire without explosion, giving rise to dense black smoke, but the application of a red-hot rod will cause it to detonate, as will also the explosion of a capsule of fulminate of mercury. Owing to the readiness with which it forms certain unstable metallic salts, the use of picric acid is not free from danger, and it is largely on this account that it is being rapidly replaced by the somewhat less energetic but much safer trinitrotoluene.

Trinol, trotyl, trilite, tritolo, or T.N.T., as trinitrotoluene is variously called, is made from toluene (obtained from coal-tar naphtha), and was first proposed for use in shells by Haüssermann, in 1891. The result of the first nitration of toluene is a mixture of mono-nitro-toluenes, which are then treated with a mixture of strong nitric acid and sulphuric acid, and raised to the third or trinitro degree of nitration in one stage. Trinitrotoluene, when pure, forms brownish-yellow crystals with a melting point of 81° C. It is very stable, not igniting below 300°, but when it explodes it does so with great violence. Its density when melted varies between 1·57 and 1·60. Neither picric acid nor trinitrotoluene can be detonated with certainty by fulminate of mercury, and a small quantity of an intermediate priming charge is employed. In the case of trinitrotoluene, the use of tetranitromethylaniline has been found suitable.

Tetranitraniline is a very powerful explosive, and has a higher density than either trinitrotoluene or picric acid.

The nitro-hydrocarbon high explosives used for the shell bursting are, in the molten state, poured into the cavity of the shell, in which they solidify, sufficient room being left for the priming charge and the detonating fuse. All the above nitro-compounds can only be obtained in a state of purity by re-crystallisation from various solvents.

Fulminate of mercury has been mentioned several times as a detonator, or initiator of explosion. Lead azide has been used, in conjunction with fulminate of mercury and tetranitromethylaniline, as a detonator for high explosives.

It will be noticed that the majority of the high explosives referred to are derived from coal-tar products, and it is therefore evident that Mr. Lloyd George's statement, "If there were a shortage in the coal supply for any reason, the consequences would be very calamitous," is one which must be taken very seriously.

GEORGE W. MACDONALD.

SCIENCE IN THE SERVICE OF THE STATE.

MODERN war is an affair of applied science—military, engineering, chemical, medical, and economic. Its successful prosecution requires more than an extremely high efficiency on the part of the officers in their professional work. Everything that chemical, physical, and engineering science can suggest must be pressed into service. The scientific men of the country have been keenly aware of this necessity from the beginning of the war, and many of them have individually done a great deal of important work for the Government and the various Services. The Royal Society has formed a War Committee, to which the Government has confided the solution of many pressing scientific problems arising out of the war. The public thanks of the country have been given to the Royal Society by Mr. Asquith. We note also with pleasure the issue, by the Council of the Chemical Society, of the letter (see p. 523) announcing that the Council has constituted itself a consultative body to consider, organise, and utilise all suggestions and inventions which may be communicated to it.

British chemists have now a clearing house for their ideas and discoveries, whilst the Government knows that it has the expert chemical advice of the country at its immediate disposal.

It is not going too far to say that practically without exception the services of the scientific laboratories of the universities, university colleges, and technical colleges have been offered to the Government. Very many—perhaps all—of these laboratories have done, and are doing, important public work relating to the war and the industries of the country. In this connection the Royal Society War Committee has done good work in organising special chemical work of an urgent character in the above-mentioned laboratories, and in obtaining from them competent young men to assist in the carrying on of the special chemical manufactures required at the present time.

The Institute of Chemistry has done excellent work in various directions. Particularly deserving of mention is the splendid public work done by the Glass Research Committee. The important scientific results obtained by this Committee have been made public (see Nature, April 15, p. 192), and are therefore at the disposal of every manufacturer.

There is not a scientific society, scientific laboratory, or scientific man in the country that is not anxious and willing to help. Much good work has been already done. But there is undoubtedly a feeling that with better organisation and knowledge a vastly greater amount could be done. Speaking in the House of Lords on Friday last, Viscount Bryce urged that—

> Every possible effort should be made to utilise the services of scientific men. They all knew to how great an extent the German Government had turned the services of scientific men and establishments for investigation and research to account for military purposes. We possessed in this country a body of scientific men not, indeed, so numerous, but fully equal in competence and fully equal, he need hardly say, in earnestness and zeal to serve their country. He understood that there had been during the past months a certain amount of regret among scientific men that they had not heard from the Government how they could help. Any efforts which the Government made to give them a chance of coming in, and enabling them to turn their scientific knowledge, whether in chemistry or engineering, to the common purpose we all had at heart would, he was certain, be welcomed by them. The universities, in which there were so many scientific men, would gladly drop all their work in order to assist

It is to be hoped that these wise words will be taken well to heart.

Science is standing Germany in good stead at present. It is known that the Badische Works, employing the process initiated by the scientific researches of Prof. Haber, had arranged for an enormous output of synthetic ammonia during the present year. About twelve years ago Prof. Ostwald, foreseeing (as he has himself publicly stated) a nitric acid famine in Germany during a period of war, investigated the conditions for the economical oxidation of ammonia to nitric acid. This process has been worked for several years at a factory near Vilvorde in Belgium. It is rumoured that Prof. Haber and the Badische Works have greatly improved the process, and that in conjunction with the synthetic ammonia process it now provides a large part of the nitric acid required by Germany for the manufacture of her explosives. *Ohne Phosphor kein Gedanke* said the materialist once upon a time. So might he now say, "No nitric acid, no war." Interesting notices have appeared from time to time in the *Chemiker Zeitung* relating to the activity of organised German science during the past twelve months. A new industry of zinc extraction has been developed, and it is reported that means have been found to replace the French bauxite required for the production of aluminium.

The shortage of copper has been discounted by the use of special alloys. It is also stated that processes have been developed for the manufacture of gasoline and lamp oil. Alcohol is being largely used in internal combustion engines.

We may feel sure that not only the universities and technical high schools, but also the splendid special laboratories of the *Kaiser Wilhelm Forschungsgesellschaft* are working at high pressure in the service of their State.

It is necessary—urgently necessary—that we should do as much, if not more. Let Britain call. British science is ready. It is straining at the leash. All that is wanted on the part of our leaders are imagination and sympathy. A little more of these, and the good that has been done can be magnified a thousandfold.

F. G. Donnan.

MAMMALS OF EASTERN EQUATORIAL AFRICA.[1]

Mr. Roosevelt's second book dealing with his East African experiences will probably be more valued by naturalists than his first, though some portions of it may leave the naturalist cold where they excite to frenzy the man of primitive instincts, who still thinks

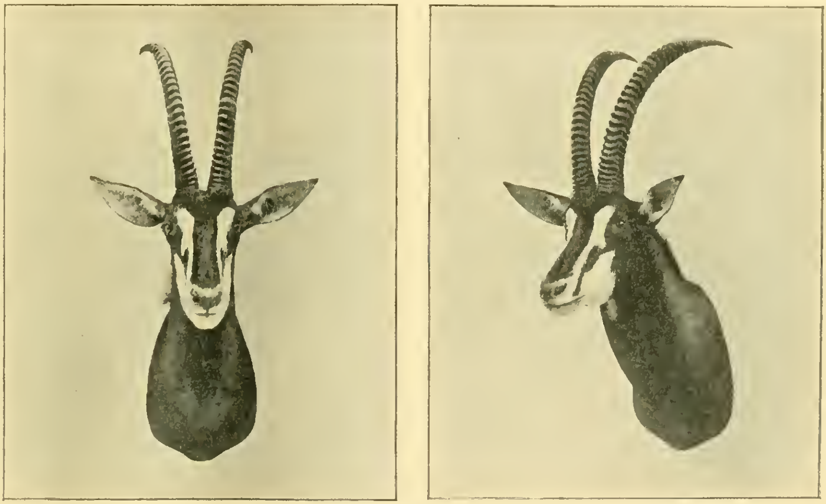
> Cet animal est très méchant,
> Quand on l'attaque il se défend

To the mammalogist *Homo sapiens*, even in his Caucasic variety and English or Anglo-American race, is not more interesting than *Felis leo* or *Loxodon africanus*; and he is just as shocked and pained at the death agonies of the latter as of the sportsman who fails to kill dead at the first shot and is afterwards eaten up or trampled under foot. In fact, I for one, when I read in a newspaper some ten years ago that a German hunter who had frequently evaded my inquiries in East Africa as to big-game regulations and had at last—thank goodness!—been killed by a rhinoceros after having needlessly slain about seventy-three rhinoceroses for no purpose whatever but sheer love of killing, could not resist an expression of delight.

[1] "Life-Histories of African Game Animals." By Theodore Roosevelt and E. Heller. Vol. i., pp. xxviii+420. Vol. ii., pp. x+421–798. (London: John Murray, 1915.) Price 42s. net. Two vols.

However, the whole purport of Mr. Roosevelt's expedition, which for the most part has received unqualified approval on the part of serious-minded naturalists, was to enrich science with necessary specimens of beasts and birds for American and British museums, and above all to study the life habits of all interesting creatures in East Africa. There was no indiscriminate slaughter and good use was made of everything killed.

All persons who are worth anything in intellectual valuation have their special *tic*, some detail or some subject about which they worry unnecessarily, and in regard to which they would unhesitatingly send to the stake all who differed from them. The subject over which Mr. Roosevelt frets—I think unduly—is the coloration of mammals—perhaps also that of birds, reptiles, insects. He is angered by the extremes to which the theory of protective or assimilative coloration has been carried by some writers who have probably wrenched facts to suit far-fetched conclusions; and seemingly he would go to the opposite pole and, apart from the flagrant cases which no one denies—of bold advertisement coloration—would almost refuse to admit that there is any purpose in coloration at all.



Roosevelt Sable: adult male. From Shimba Hills, British East Africa. From "Life-Histories of African Game Animals."

Those who have seen much of beasts, birds, and insects in the tropics or in the wild regions of the temperate zone still adhere to the general theory that the coloration of living things has been gradually developed to serve a purpose useful in the main for the preservation and prosperity of the species. Yet the direction of this mental reflex on corporeal matter by no means seems all-wise from the point of view of the human critic. It does not—as Mr. Roosevelt points out—always lead to the betterment of the species or the well-being of the individual. Just as the *summum bonum* of daily fare on British steamers used to be governed by the steward's ideal of what he liked best in his humble home at Liverpool or Southampton, so the markings and outward aspect of this and that species of mammal, bird, and insect in some cases evince nothing of "divine" foreknowledge in the pattern, but seem rather to be the expression of some low, and possibly stupid, "intelligence": an ideal formed in the continuous mind of the species which passes on from individual to individual. Yet in most cases this ideal in colour and markings has unquestionably served a purpose, if a base one.

Wild creatures are far less conspicuous—unless they desire to advertise themselves—in their natural habitat than are the domestic animals of man's creation and protection. I remember once on the borders of Ovampoland, when I was comparatively new to Tropical Africa, gazing from a hillock over a vast swampy plain to see if there was any big game to be shot. My eye at once noted the great herds of native cattle—red, brown, black, black and white—distinguishable from their surroundings with the utmost ease. I decided there was no game in sight, but my native guides pointed excitedly in another direction. At first I could detach nothing from the shrubs, the ant-hills, the sedges, and the thorns, until at length, by the mere fact that they moved, I made out the forms of buffaloes and antelopes. The creatures the mind action of which was subordinated to ours, and which cared nothing for concealment, were at once visible to the eye, detached from their surroundings, and there, as elsewhere, an easy prey to the Carnivora. But the wild fauna of the country was most difficult to detect by the eye; and other facts which have come to my notice have shown me that many of the great Herbivora actually escape notice by lions, leopards, chitas, hunting-dogs, and so forth, unless the wind turns against them and their presence is detected by a sense of smell. However, I do not wish to cross lances with Mr. Roosevelt, whose own theories in the main tally with the facts, but who always seems to me to get unnecessarily contentious about what he has in indirect ways himself to admit—that there *is* a purpose, even if it be at times a paltry one, running

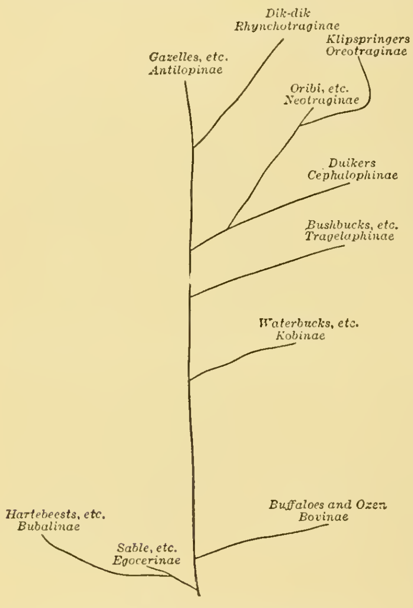


Diagram of the family Bovidæ showing relationships of the sub-families. From "Life-Histories of African Game Animals."

through the coloration of all the living creatures of this planet.

I, too, have my *tic*: and that is the classification, the phylogeny, of the Bovidæ. Probably it is Mr. Heller with whom I am about to fall out, and not Mr. Roosevelt. But one or other has introduced into the work under review theories and diagrams as to the descent and interrelationships of the antelopes and other bovids which are not only a perpetuation of nineteenth-century errors and misconceptions, but do not square with the facts of the comparative anatomy of the bovids, as set forth even as far back as the early 'eighties by the late Prof. A. H. Garrod; and in a very lucid and remarkable manner in our own day by Mr. R. I. Pocock, of the Zoological Society, as well as by the authorities of the British Museum (including the late Mr. Lydekker). Nor do they agree with what may be deduced from the most recent palæontological discoveries in Europe and North America.

In Mr. Roosevelt's book sufficient emphasis is not laid on the marked distinction existing between the tragelaphs and the antelopes. The mistakes in classification, which have travelled so far from Sclater and Thomas's otherwise admirable book of antelopes, have infected the ideas of either Mr. Roosevelt or Mr. Heller. These ideas include an unnatural isolation of the hartebeests and gnus, a misconception of the position of the oryx sub-family, and of the relations in general between the true antelopes with annulated horns, the goats, sheep, and capricorns (likewise with annulated horns where they retain primitive features), the oxen (with a trace of annulation on the horns of the most primitive types of Congo buffalo and anoa), and the tragelaphs (eland, bongo, kudu, bushbuck, and nilghai) without annulations.

This last sub-family has a few more primitive features in its skeleton and anatomy than the other divisions of the Bovidæ, though the ancestors of the oxen may have been not unlike the nilghai in appearance and anatomy, and in some way link the ancestral tragelaphs with the other groups. Notable among these "primitive" features are the ancient ungulate white spots and stripes, prevalent in some perissodactyls, in swine, tragelids, deer, tragelaphines, and Asiatic buffaloes; but absent from antelopes, sheep, and goats. Probably the most primitive of the existing tragelaphs is the four-horned antelope of India. Its existence there, and that of the nilghai, conveys an idea that the tragelaphines originated in Asia, spreading thence to South-eastern Europe and Africa, on the one hand, and even to North America on the other. Amongst the true antelopes themselves, the duykers and neotragines are obviously the most primitive of existing forms, and apparently first developed from the basal stock of the bovids in France or Southern Europe. From them arose the gazelles, or gazelle-like forms, which have "proliferated" in course of time into pallas, topis (Damaliscus), hartebeests, and gnus. The pallas have specialised in some points, such as reduction of the mammæ, but they are very suggestive in others of the vanished link between gazelles and hartebeests. The neotragines, possibly, were ancestral to the Cobus group; and the primitive Cobine stock seems to have given birth to the remarkable orygine sub-family (addax, hippotragus, and oryx).

Mr. Roosevelt's book throws a good deal of light on the problem of the origin and descent of the Bovidæ, even though his or Mr. Heller's theories are not in all points acceptable—at any rate to this reviewer of his book.

The book is most effectively illustrated by photographs, drawings, maps, and diagrams.

H. H. JOHNSTON.

ORGANISATION OF SCIENTIFIC WORK IN INDIA.[1]

THE Board of Scientific Advice for India was established in 1903. When first created it was composed exclusively of, and still includes, the officers for the time being in administrative charge of the various scientific departments of the Government of India. The object primarily in view was to enable the heads of these departments to meet at stated intervals for the purpose of considering the programmes of work proposed to be undertaken by each during a coming season. The number of problems awaiting attention in so vast an area as our Indian Dependency has always been greater than the staffs of the combined scientific departments can ever hope to deal with at any one time. The avoidance of wasted effort is, therefore, in India more urgently essential even than at home. The degree to which interest attaches to problems that lie on the borderline where the activities of cognate departments meet is just as great in India as elsewhere. Questions relating to the soil are of paramount importance in a land in which agriculture is the fundamental industry; such questions often affect the officers of the Geological Survey as much as they do those of the Department of Agriculture. Questions relating to the constituents of an indigenous flora are often only second in importance to those concerning cultivated plants; such questions may be of equal interest to the Botanical Survey and the Forest Service. Yet other questions may be of interest to the zoologist on the one hand, to the veterinary officer, the forester, or the agriculturist on the other.

The high traditions of all branches of the public service in India are of long standing, and to the self-effacement which is so characteristic of her officers has been united a singular absence of jealous rivalry and a peculiar readiness to render mutual aid. Instances of the simultaneous and conscious undertaking by two departments of the investigation of the same problem have therefore been in India remarkably rare. This being the case, the establishment of a Board of Scientific Advice, with as one of its main objects the automatic elimination of overlapping of work, was perhaps less essential than the institution of such a body might be in certain other countries. Still, if in this respect the functions of the Indian Board have scarcely had to be exercised, the existence of such a body remains a desirable precaution, while since the Board was constituted it has proved advantageous by bringing about what it was in a manner constituted to prevent. For when some border-line problem now suggests itself for study to some one department, other departments are in a position to consider, at the outset, its bearing on their own work and interests. Two departments are now sometimes able to deal with one problem, and by simultaneous attack along different lines to secure results which neither department, working alone, might hope to attain in double the time. In connection with this aspect of its activities the Board has, to the public advantage, been strengthened by the addition of scientific men who are not necessarily at the head of Government departments.

Since its inception, this Indian Board has taken into consideration, along with programmes of future work, the progress of inquiries actually in hand and the results of investigations which have been concluded. Such inquiries are made the subject of an annual report. This report by the Board, it should be understood, is not to be taken as a substitute for or even as a *resumé* of the annual reports of the different scientific departments represented thereon. Those who desire to make themselves acquainted with the operations of the Surveyor-General, the Meteorological Reporter, the Inspectors-General of Forestry or of Agriculture, the Directors of the Geological or the Botanical Surveys, must study the official reports issued by these various officers. But the reader who has no such special object in view, yet wishes to form some estimate of the extent to which scientific studies are being systematically prosecuted and scientific results are being economically applied in India, will find in the Report of the Board of Scientific Advice succinct accounts by authorised and competent officers of these scientific activities during a given year.

The report of the Board for 1913–14, which lies before us, testifies to the variety of these activities and to the attention bestowed on investigation and research in India. Among the more generally interesting items in this particular report are an account by Mr. G. T. Walker of the equipment of the Solar Physics Laboratory at Kodaikánal; a note by Mr. H. H. Hayden on the materials available for the construction of Imperial Delhi; a report by Mr. R. C. Burton on the quantity of pitchblende available in the Singar mica mines; the record by Lieut.-Colonel G. P. Lenox-Conyngham of the completion of the Indian portion of the connection between the triangulations of Russia and India; and the more hopeful prospects with regard to the cultivation of the African plant known as *Java* Indigo, reported in a note by Mr. A. Howard of the Pusa Institute. But the whole report repays perusal, while one of its most useful features is the list of publications which accompanies each of its sections.

[1] Annual Report of the Board of Scientific Advice for India for the Year 1913–14. Pp. 175. (Calcutta: Superintendent Government Printing, India, 1915.) Price 1*s.* 4*d.*

NOTES.

IT is officially announced that Admiral of the Fleet Lord Fisher of Kilverstone has been appointed chairman of the Inventions Board which is being established to assist the Admiralty in co-ordinating and encouraging scientific effort in its relation to the requirements of the Naval Service. A further announcement will be made as to the *personnel* of the new Board and the address of its offices.

IN reply to a question asked by Sir Philip Magnus in the House of Commons on July 1, the Minister of

Munitions, Mr. Lloyd George, said he was fully alive to the great importance of securing the co-operation of scientific workers, and of utilising so far as practicable the laboratories and workshops of our universities and technical schools for experiments and for making munitions of war. Replying to further questions, Mr. Lloyd George added that he hoped in a very short time to be able to do something in the nature of the work done in France by M. Albert Thomas, who was bringing officers from the Front to confer with members of the Academy of Science; and that he had within the past few days been discussing the question of establishing a central committee or bureau.

In the House of Lords on July 2, Lord Bryce urged the Government to make every possible effort to utilise the services of scientific men, and said that a call to co-operation would be welcomed by all British chemists and engineers. Replying at the end of the debate, Earl Curzon referred to the surprise expressed that, considering the great resources of scientific ability in this country and the willingness shown by our men of science to be of service, more use had not been made of them. He fancied, he said, a great deal more advantage had been taken of these than was known generally. For instance, a committee of the Royal Society had rendered valuable aid, and the Admiralty and War Office could give a number of cases in which offers of scientific assistance had been accepted and advantage had ensued. He held out the hope that it would be possible to arrange to make still greater use of the services of men of science.

At the annual general meeting of the British Academy held on June 30, Lord Bryce, president, in the chair, the following were elected Fellows of the Academy:—Mr. H. Stuart-Jones, Director of the British School at Rome 1903–5; Sir Charles Lyall, Prof. D. S. Margoliouth, Mr. W. L. Newman, Sir James H. Ramsay, Bart., of Banff, and Prof. W. R. Scott.

Among the recent additions to the zoological department at South Kensington are some specimens which are surely destined to possess historical interest for posterity. They consist only of two or three examples of harvest-mice and one house-mouse, but they were caught in the trenches in northern France, in that part of the trenches, in fact, occupied by some of our Indian troops. These specimens were collected and presented to the museum by one of the officers of an Indian regiment, whose keenness for his favourite pursuit of natural history allowed him in the intervals of being heavily shelled by the enemy a little relaxation in the way of trapping and skinning any animals for the national museum in London.

The council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane prize for the biennial period 1912–14 to Prof. C. R. Marshall, Dundee and St. Andrews, for his studies on the pharmacological action of tetra-alkyl ammonium compounds. The prize and medal were presented at the meeting of July 5. These researches of Prof. Marshall's may be described as the direct outcome of investigations which were published in the Transactions of the Royal Society of Edinburgh by Prof. Crum Brown and Sir Thomas Fraser in 1869—more than forty-five years ago—and have been continued since by various pharmacologists, amongst others by two distinguished graduates of Edinburgh University working in collaboration, Sir Lauder Brunton and Prof. Theodore Cash, whose work was published in the Philosophical Transactions of the Royal Society in 1884.

The council of the Salmon and Trout Association is seeking data as to the possibility of increasing the supply of fly-food in trout streams, and is inviting anglers and fishery owners to give details of cases in which the valuable water-bred flies have been increased substantially in number by any special measures such as the introduction, by the planting of eggs or larvæ, or the liberation of mature flies on the banks of a river or lake; and the improvement of a stream or lake by the cultivation of special weeds, careful removal of mud, and so on. The tabulation of specific results, with an account of the measures taken, would be of interest and value, and if sufficient information is forthcoming, it is hoped to publish it in the association's quarterly journal, the *Salmon and Trout Magazine*. Communications, addressed to the honorary secretary, Sir Wrench Towse, or to the editor of the magazine, Fishmongers' Hall, London, E.C., will be acknowledged.

The death is announced, at seventy-seven years of age, of Mr. F. E. Kitchener, who served as Assistant Commissioner to the Royal Commission on Secondary Education, and was the author of a "Geometrical Note-Book," "Naked Eye Botany," and other works.

We regret to record the death, at Dulwich, on June 26, of Mr. A. C. Hurtzig. Some particulars of his career are given in the *Engineer* for July 2. Mr. Hurtzig was born in September, 1853, and was educated at Ware Grammar School and at University College, London, where he was one of the earliest students in the engineering faculty. His early experience was gained on railways and harbours in Ireland. In 1888 he became chief assistant to Sir John Fowler and Sir Benjamin Baker. Sir John Fowler died in 1898, and, on the death of Sir Benjamin Baker, Mr. Hurtzig became head of the firm. He completed Sir Benjamin Baker's work for the Egyptian Government in respect of the raising of the Assuan Dam and the building of the Isna barrage, and was engineer of the Forth Bridge Railway Company to the time of his death. He was a member of the Institution of Civil Engineers, and also of the Iron and Steel Institute.

Mr. C. E. P. Spagnoletti, a well-known British electrical engineer, of Italian origin, who was born at Brompton in July, 1832, died at Hampstead on June 28. He was employed by the Electric Telegraph Company from 1847 until 1855, when he entered the service of the Great Western Railway as chief of their telegraphic department. He remained chief electrician and telegraph engineer of that railway company for thirty-seven years. In 1865 the London Metropolitan Railway was opened and worked on the Great Western Railway system, and in the same year Mr. Spagnoletti brought out his disc-block instrument for controlling the traffic on the Metropolitan lines. He was responsible also for numerous other electrical appliances for use on railways. He became consulting engineer to the City and South London Railway in 1889. Mr. Spagnoletti was president, in 1885, of the Society of Telegraph Engineers and Electricians (now the Institution of Electrical Engineers), a member of the Institution of Civil Engineers, of the Royal Society of Arts, and of the Physical Society.

Dr. Robert Heath Lock, whose untimely death was recorded in Nature of July 1, was born in 1879. From Charterhouse he entered Gonville and Caius College as a scholar in 1899. After distinguishing himself in the Natural Sciences Tripos, he became Frank Smart student of the college, and was elected a fellow two years later. Lock took his degree at the time when the rediscovery of Mendel's work opened up new possibilities of research for the botanist. Through the influence of Bateson, these possibilities were at once recognised in Cambridge, and Lock determined to go to the tropics in order to start experimental work on Mendelian lines. He proceeded to the well-known Botanic Gardens of Peradeniya in Ceylon, and for several years was busily engaged in breeding work with maize and peas. Both these plants, especially the former, lend themselves readily to the recording of considerable numbers of observations. Lock took full advantage of this, and the extensive data he obtained—in one set of experiments with maize more than 50,000 records were made—made it clear that for certain characters, such as the white and yellow colour of maize seeds, the Mendelian rule of segregation was exhibited with remarkable accuracy. His experiments with peas confirmed his conclusions from those with maize, and he further published some interesting results on more complicated Mendelian phenomena. He returned to England in 1905, when he became curator of the herbarium at Cambridge, and did valuable work in organising the library of the botanical department. At the same time he started experiments with Nicotiana, of which an account afterwards appeared in the Journal of the Royal Botanic Gardens of Peradeniya. In 1908 he returned to Peradeniya as assistant-director. Shortly afterwards he became acting-director, in which position the demands on his time practically put a stop to his own researches, though he did much useful work in connection with the rapidly growing rubber industry. Changes in the administration of the Peradeniya Gardens brought him back to England once more, when he took up the post of inspector under the Board of Agriculture, which he held until the time of his death. Lock's work did much towards laying a sound foundation for genetic science, the results of which he helped to popularise in a clearly written little book. His record makes us regret that the cares of administrative work should have prevented his following up his earlier successes in research.

In a lecture before the British Astronomical Association on Wednesday, June 30, on recent developments in the applications of electricity to precision clocks for observatories, Mr. F. Hope-Jones, chairman of the Wireless Society of London, spoke feelingly of the loss of the wireless time-signals in war time. Throughout the year 1913 and until early in August last, when all privately owned wireless installations were dismantled by order of the Postmaster-General, the rhythmic signals were observed every night at 11.30; and by means of the "acoustic vernier" the rate of an astronomical regulator running on test was determined in hundredths of a second. Since then the old laborious method of testing and rating has had to be reverted to, requiring months instead of days. Referring to the fight for freedom to listen to the international wireless time-service signals without taxation, and its successful issue shortly before the war, Mr. Hope-Jones expressed the hope that these privileges would be restored in their entirety on declaration of peace. When that day arrived, it might be necessary for the scientific world to act in concert and present this claim with unanimity and force.

The Scripps Institution at La Jolla, near San Diego, California, is, says *Science*, to have its facilities improved. Miss E. B. Scripps has announced to the University of California her intention to give during the next two years 20,000*l.* for further equipment. A pier a thousand feet in length will be built, at which can lie the *Alexander Agassiz*, the sea-going vessel owned by the institution and used exclusively for its work. Additional aquarium facilities will be provided, all planned to be useful for scientific purposes, but in part to be available for public educational objects. A salt-water pumping plant and settling basin are also to be added. Quarters for scientific assistants and graduate students are also to be arranged. The Scripps Institution has a site of 177 acres, with half a mile of ocean frontage, well-equipped laboratories, residences for the scientific staff, a good working library, and excellent equipment. The land was given by the city of San Diego, while for the most part the other equipment has come by the gift of Miss Scripps, who has created also an endowment of 30,000*l.* for its work. The State of California gives to the University of California 1500*l.* per annum as a contribution towards the work of the institution, and the director, Mr. E. Ritter, and his staff give their whole time to the research work.

The leading article in *Engineering* for July 2 is devoted to a discussion on French and German guns. An explanation has been given by M. R. Arnoux before the French Society of Civil Engineers of the cause of death produced by the bursting of French 75 mm. and other high-explosive shells. From evidence furnished by a pocket aneroid barometer which had been rendered unserviceable by the explosion close to it of a German high-explosive shell, it appears that the explosion had produced, at a distance of fewer than 3 metres, a sudden barometric depression in the room where the instrument was placed of at least 350 mm. of mercury, corresponding to a driving velocity of the air of 276 metres per second, and to a dynamic pressure of 10,360 kilograms per square metre. In the case of men sheltered behind any kind of protection, the very sudden static depression of the surrounding atmosphere comes into play, and many are killed without signs of wounds. The explanation put forward is that the air and carbonic acid in solution in the blood are disengaged in the shape of minute gaseous bubbles as soon as the pressure decreases too suddenly from any cause. These bubbles are driven into the small arteries under the influence of the pressure exerted by the heart. If their diameter is greater than that of the small arteries, they form so many gaseous plugs, which instantaneously stop the blood circulation, and death occurs before there is time for them to dissolve back in the blood when the ambient atmospheric pressure returns to normal. The radius of action of high-explosive shells is less than the possible one of shrapnel for killing purposes, but they are more deadly than shrapnel, for in their radius of action no living being escapes, whilst the shrapnel is dangerous only when one of its balls or fragments strikes home.

THE report of the Marlborough College Natural History Society has just reached us. It contains one feature which the reports of other public schools might well follow. This is the Anthropometrical Report, giving the height, weight, and chest measurements of boys weighed during February, May, and October, 1914. This is an extremely useful piece of work, and might well be extended to include other details, such as the span of the arms, hair and eye colour, and the cephalic index. The sectional reports—zoological, botanical, and photographic—all give proof of keenness and shrewdness of observation.

A BRIEF but excellent summary of the life-history of the woodlark, by Mr. W. Farren, appears in *Wild Life* for June. The author's observations were made in the Breck district of Cambridgeshire, where this bird appears to be on the increase owing to the extension of plantations. He makes some interesting comparisons between this species and its ally, the skylark, more especially in regard to the method of feeding the young. The woodlark, it would seem, suffers an unusually high infant mortality owing to the raids of mice on the eggs and very young nestlings. Some very beautiful photographs add much to the value of this short essay.

IN connection with the article in NATURE of June 17 on "Jamaica as a Centre for Botanical Research in the Tropics," it is desirable that attention should be directed to the interesting descriptive account of the laboratory and garden at Cinchona, given by Prof. Duncan S. Johnson in the *Popular Science Monthly*, vol. lxxxv., No. 6, 1914, and vol. lxxxvi., No. 1, 1915. The history of Cinchona, which was established in 1869, is given, and is followed by an excellent account of the laboratory and the magnificent tropical vegetation by which it is surrounded. The articles are illustrated by numerous photographic reproductions, in which the luxuriance of the tree-fern growth in particular is well shown.

THE dire consequences of the reckless destruction of timber on the Victorian "flood-plain" are convincingly shown by Mr. J. G. O'Donohue in the *Victorian Naturalist* for May. Barren, treeless wastes of huge extent now mark the sites of once flourishing forests. No use is made of the clearings thus made, which have become, indeed, a source of danger to the Murray River, rendering its navigation more difficult each year owing to the detritus carried into it by the storm and flood waters now that the vegetation no longer serves as a filter and to hold the soil. The observations on the animal life and the botany of the area explored make profitable reading. Among other things he comments on the ravages caused among the aborigines by smallpox. Hundreds of bodies lay buried in one of the sand-dunes he traversed, and some of them were disinterred. In the course of his stay in this region he gathered conclusive evidence disposing of the oft-repeated statement that the doe kangaroo, when hard pressed, deliberately throws her young one from her pouch. The ejection invariably and unintentionally follows on a long pursuit. The young one is "sent spinning from the pouch as the mother, by her enormous leaps, imparts to it a more or less vertical motion."

IN view of the number of deaths from anthrax that occur among those employed in the leather industry, especially in the handling of imported hides, a paper in the *Journal of Agricultural Research*, vol. iv., No. 1, on the disinfection of hides infected with anthrax spores, has more than ordinary interest. Mr. F. W. Tilley has investigated the efficiency of the Seymour-Jones and Schattenfroh methods which have been proposed during the last few years. The problem is difficult owing to the high resistance of anthrax spores and the necessity that the hides shall not be injuriously affected from the tanner's point of view. The author finds that the strength of disinfectant originally recommended by Seymour-Jones (mercuric chloride 1 in 5000 plus 1 per cent. formic acid) is not efficient, but 1 in 2500 is efficient if the hides are not subjected to a neutralising solution for a week or two after disinfection. If, however, the hides are immersed in sodium sulphide, as ordinarily used by tanners for dehairing, within three or four days of disinfection, even this higher strength is not sufficient to prevent fatal infection to guinea-pigs from disinfected material. For this reason the process is recommended only when the hides are treated at the port of shipment. The Schattenfroh method (2 per cent. hydrochloric acid plus 10 per cent. sodium chloride) proved entirely satisfactory from the bacteriological point of view, forty-eight hours' exposure proving efficient in every instance. Sevčik, however, has reported that while with thin hides the results were good, thick, heavily infected hides were found to contain spores virulent to mice even after seven days' exposure. The author nevertheless thinks that the Schattenfroh method is so far superior to other methods as to be well worth a trial as a standard process of disinfection for hides. Pieces of hide treated by both methods were found to be uninjured after passing through the usual tanning processes.

IN recent years German and Austrian anatomists have devoted much attention to the possibility of reconstructing the likeness of a person when merely the bones of the head and face remain to serve them as a guide. The matter has also been taken up by anatomists in America. Recently Prof. Charles W. M. Poynter, of the University of Nebraska, handed three human skulls to an artist with the request that the soft parts of the face and head might be reconstructed according to the data published by Prof. von Eggeling, of the University of Jena. The artist did not know that the three skulls belonged to natives of North America, one being a skull found in a Nebraska loess mound by Mr. Robert F. Gilder, and possibly of Pleistocene age, another belonged to an Indian of pre-Columbian date, while the third was that of a modern Indian. Photographs of the plastic reconstructions made by the artist have been published in the illustrated Press of America, the American-Indian type of countenance being very apparent in all three. Whatever the age of the Nebraska loess skull may prove to be, there can be no doubt, from its osteological characters, that its owner was a man of the Indian type. The plastic reconstructions show that the artist had come unconsciously to the same conclusion.

THE appointment of Dr. R. E. Fries to the directorship of the Bergielund Botanic Garden is recorded in *Kew Bulletin* No. 4. Dr. Fries, who has travelled widely in South America and published extensively in various domains of botany, carries on the botanical traditions of his father, Prof. T. M. Fries, and his grandfather, E. M. Fries, the brilliant expositor of the Fungi. The Bergielund garden is at Albano, near Stockholm, and was bequeathed to the Royal Academy of Science by Bergius, the pupil of Linnæus, well known for his work on Cape plants. His bequest, in addition to the garden of 17 acres, comprised his extensive library and herbarium as well as much of his estate.

MISS MAUD D. HAVILAND records some very interesting observations, which have the additional merit of being for the most part new, on the courtship of the lapwing in the *Zoologist* for June. Under the term "courtship" she includes all behaviour that is peculiar to the bird in spring time, but the only emotional display, she contends, which is to be interpreted as a deliberate display to a prospective mate, is the exhibition of the richly coloured chestnut under tail-coverts. Miss Haviland confirms the view that the amatory exercises of these birds take place within a circumscribed area, more or less distant from the nesting place. While making no claim to originality for her interpretation of the origin of nest-building, she makes some trenchant criticisms on certain grotesque theories which have been propounded on this subject.

THE recently issued number (tome xiv., 1914) of the *Bulletin du Jardin Impérial Botanique de Pierre le Grand* contains several interesting papers in Russian, which, fortunately, are provided with summaries in French. Mlle. Ljabitzkaja contributes an account illustrated with excellent plates dealing with the various forms of *Leucobryum glaucum*, the moss which occurs in the form of free, rounded, disc-like masses with radially arranged stems sometimes met with in England. A map of the distribution of the various forms in Russia is also included. The author considers that only the single species, *L. glaucum*, occurs in Europe, the ball-like form being var. *subsecundum*. The moss, except in the west of the Caucasus, is always infertile, and the author considers the fertile form of the Czemomorsk region to be a new variety, which he calls var. *gracile*.

IN continuation of the series of researches on the development of minerals from igneous magmas, which we owe to workers in the United States, Mr. Olaf Andersen has examined the supposed binary system, $CaAl_2Si_2O_8-MgSiO_3$ (*American Journal of Science*, vol. xxxix., p. 408). The $MgSiO_3$ constituent proved to be unstable at its melting point, breaking up into forsterite and a melt. Silica appeared as cristobalite and tridymite. In certain mixtures, moreover, spinel arose, deriving its alumina from the anorthite molecule, which also became unstable. Spinel is in consequence regarded as originating in igneous rocks from a homogeneous magma. The crystallisation of forsterite under the conditions of the experiments is interestingly shown to explain the known relations between olivine and pyroxene in igneous rocks.

THE Geological Survey of Great Britain, since our notice at the end of April (NATURE, vol. xcv., p. 242), has issued a memoir to Sheet 269, price 2s. 6d., on the country around Windsor and Chertsey. The authors, Messrs. Dewey and Bromehead, show how the commanding site chosen for Windsor Castle is due to the erosion of an anticline of chalk, which here rises from beneath the level Cainozoic beds. It will be new to many readers that the Ditrupa sandstones in the London Clay are capable of forming waterfalls in the local streams. The sequence of flint implements in the gravel-terraces is discussed. The Scottish Branch gives us a memoir to Sheet 74, on the difficult country of Mid-Strathspey and Strathearn (price 2s. 6d.). The great alluvial cones and terraces connected with overflow-channels of glacial days are finely illustrated. The book is one that will add greatly to the pleasure of any intelligent visitor to Aviemore and the historic Grampian road.

THE severe thunderstorm which passed over the central parts of London on the evening of May 6 is dealt with in *Symons's Meteorological Magazine*. A map is given which shows very clearly the limited area over which the rainfall was heavy. Only four rainfall records have been received from the six square miles which embrace the region with a rainfall of more than 1·5 in. The measurements are 1·70 in. at Messrs. Negretti and Zambra's premises at Holborn Viaduct; 1·76 in. at Mr. Steward's in the Strand; 3·00 in. at the Holborn Borough Stone Yard; and 3·12 in. at New River Head, the office of the Northern District of the Metropolitan Water Board. It is stated that more than 3 in. of rain possibly fell on an area, about half a mile wide and a mile and a half long, between the City and King's Cross. Mr. J. M. Wood, Engineer for the Northern District of the Metropolitan Water Board, made the following careful and interesting report. "On Thursday evening, the 6th instant, I recorded 3·12 in. of rain between 8.30 p.m. and 10 p.m., due to the thunderstorm. There can be no doubt about the time and quantity, as I had the rain-gauge checked by tanks and trucks which stood close by."

A SCIENTIFIC paper recently issued by the Bureau of Standards deals with the emissivities of metals and oxides at temperatures near their melting points. The work is by Messrs. G. K. Burgess and R. G. Waltenberg, who use throughout the micropyrometer invented by the former three years ago. A speck of the substance weighing about a hundredth of a milligram is placed on a platinum strip which can be heated in an atmosphere of air, hydrogen, or other gas until the substance melts. On cooling it presents a smooth, clean surface. The carbon or tungsten filament of the micropyrometer is then brought alternately to the same brightness as the bare and as the covered platinum when viewed through coloured glasses. The emissivity of platinum being known for all the temperatures used, the temperatures and emissivities of the substances can be calculated. For the wave-lengths at which the comparisons are made the metals do not appear to change their emissivities much in the 20° C. below their melting points, but some of them and some of their oxides show a marked increase of emissivity on melting. This increase of emissivity on melting in the case of platinum makes the Violle unit of light uncertain.

THE Economic Proceedings of the Royal Dublin Society (vol. ii., No. 10, p. 161) contains an account by Prof. G. T. Morgan and Mr. G. E. Scharff of preliminary experiments on the utilisation of peat tar. The tar produced by distilling peat in retorts, producer gas plants, or other suitable distilling apparatus, yields certain neutral oils which differ from the aromatic oils of coal tar and from the paraffins in having a highly unsaturated character manifested by the rapid absorption of atmospheric oxygen. The alkaline extraction of these oils leads to the separation of acidic oils of high boiling point and of great germicidal power. The higher fractions of the neutral oils yield waxes resembling the Montana wax of lignite. The crude peat tar oil contains small amounts of basic substances of the pyridine group, whilst the residue of the distillation is a typical soft pitch.

AN interesting paper on a greatly improved hæmin test for blood is published by Dr. William Beam and Mr. Gilbert A. Freak in the *Biochemical Journal* (vol ix., p. 161). The difficulties experienced with Teichmann's test when applied to stains, both fresh and old, are due chiefly to the too rapid evaporation of the solvent, and, to a less extent, to interference of the albuminous matter of the blood with the crystallisation. Evaporation should be extremely slow, and when carried out in the manner detailed in the original paper, which also eliminates the harmful effect of albumin, crystals are obtained with the greatest certainty and of remarkably large size, even though only a minute amount of blood be present. The test as described was found to be equally applicable to bloodstains, fresh or even twelve years old, stains partially removed by soap and water or heated to 110°, or mixed with earth, or to old stains on rusty iron which had been exposed to strong sunlight and atmospheric conditions during several days. Of the reagents which have been recommended for Teichmann's test, acetic acid is by far the best. It suffices for the test with bloodstains which have not been extracted with water, but as a precautionary measure it is best to use a reagent containing a minute proportion—about 0·01 per cent.—of sodium chloride.

THE Journal of the Society of Chemical Industry (vol. xxxiv., No. 10, May 31) contains an account by Dr. E. Howard Tripp of a novel system of sewage treatment, called the Dickson centrifuge process. The Dickson method of separating the solids from sludge consists in treating it with 0·5 per cent. of yeast for twenty-four hours at 33° C. Owing to the escape of gases set free by anaerobic fermentation, the solids rise to the surface, from which they are run off; in this manner fully half the water-content of the sludge is eliminated. Live brewer's yeast is the most effective agent, but dextrose, starch, and other substances which act as nutrients to the bacteria, produce the same result The separated sludge is then completely dried by exposure to hot air in a plant which resembles that used in France for drying pulverised coal-dust. The dried material contains 3 per cent. of nitrogen and 50 per cent. of organic matter, and has proved itself to be a valuable fertiliser, either alone or as a base for artificials. The centrifuge treatment of effluents of all kinds consists in passing them through a centrifugal machine the perimeter of which is perforated and covered with a layer of sand. In its passage through the interstices of the sand, a bad effluent is completely oxidised and becomes supersaturated with oxygen; if it be further treated in a small contact bed and again centrifuged, the purification, both chemical and bacteriological, appears to be complete. The city analyst of Winnipeg found that the reduction of bacteria in a sewage effluent was from 8,150,000 to 1,150,000 per c.c., and that the *B. coli* were completely eliminated.

A PROBLEM which is perpetually presenting itself in chemical work is to distinguish "mere" polymorphism from the more labile types of isomerism and polymerism. Perhaps the most conspicuous illustration is that of ice, which exists in several dense, as well as in one or more light, modifications; it is suspected that all the dense modifications may be polymorphous forms of dihydrol, H_4O_2, and that all the modifications which are lighter than water may be polymorphous forms of trihydrol, H_6O_3; but it is not easy to prove whether this view is correct or not. In the case of certain optically-active substances, such as the two varieties of glucose, conclusive evidence of isomerism or polymerism is found in the fact that freshly prepared solutions of the two forms exhibit unequal rotatory powers, gradually converging to a common value as a condition of equilibrium is attained; if the difference had consisted merely in the dissimilar marshalling of identical molecules in the crystals, every point of contrast would have disappeared instantly on dissolution or fusion. Unfortunately optical activity is an exceptional attribute, and a method depending on solubility which has been described recently by Mr. N. V. Sidgwick, in the Journal of the Chemical Society (vol. cvii., p. 672), promises to become applicable on a somewhat wider scale. The isomerism of the two forms of benzoylcamphor has been confirmed by the new method, and similar phenomena have been detected in two additional cases. Negative results indicate that in other cases the modifications may be due to polymorphism, but this conclusion can only be tentative, as identical results would be produced by rapid isomeric or polymeric changes.

OUR ASTRONOMICAL COLUMN.

The Meteor Season.—Mr. Denning writes:—"There is a special season for many things, and meteors have their more favourable times and periods. Astronomers generally regard the months of August and November as the particular dates when meteors are abundantly displayed. There is substantial ground for this idea. August and November are memorable as having been the months of occasional brilliant exhibitions of meteors in the modern past. In more ancient times July and October were the favoured months by the same meteoric systems, which have slowly advanced in their dates owing to changes in astronomical conditions. To the regular observer the meteoric season may be said to open at about the middle of July, when there occurs a decided increase in the visible number of meteors contemporary with the first oncoming of the Great Perseid shower. We may usually observe twice as many meteors during the last half of July as in the first half. This is not wholly due to the activity of two or three special showers, but is partly attributable to a general increase in meteoric phenomena. July often affords a most agreeable recompense to the observer in supplying plenty of interesting objects, and this is always appreciated after their rarity in preceding months. Thus in June, 1915, at Bristol, only thirty-six meteors were seen in watches of the sky extending over $20\frac{1}{2}$ hours, a degree of scarcity which I never remember to have previously experienced. The Perseids ought to be splendidly witnessed this year with suitable weather about August 9–13. The path of the larger meteors should be carefully recorded, also the time when the maximum number of meteors is visible."

Displacements of Enhanced Iron Lines at Centre of the Sun's Disc.—The general displacement of the solar lines towards the red has been interpreted at the Kodaikanal Observatory as due to movements of the solar gases in the line of sight and not to pressure; the movement is one of recession from the earth or a falling movement at the centre of the sun's disc. Thus a circulation of the solar gases is suggested, the cooler gases falling and being replaced by the hotter gases ascending from below; such a circulation might account for the relatively great intensity of the enhanced lines of iron and other substances in eclipse spectra as compared with their intensities in the Frauenhofer spectrum. With a view to detect the rising movement of the hotter gases, Dr. Evershed and Naragana Ayyar (Kodaikanal Observatory Bulletin 46) have made a special study of the enhanced lines of iron in the sun and in the electric arc, the results of which they now publish. Details are given as to the spectrograph employed, method of producing the enhanced lines, times of exposure, etc., and a table is published showing the shifts of enhanced lines at the centre of the sun's disc. The list gives the results for sixteen lines which are of sufficient intensity for accurate measurement, and in every case except one these enhanced lines give positive shifts, showing that they cannot represent ascending gases as was supposed. Investigating the possibility of any relative shift between the enhanced and ordinary lines they find that there is none. Then they conclude "that the enhanced lines of iron in the sun give therefore no evidence of a radial circulation of the solar gases nor of any relative movement compared with the arc lines."

The Maximum Brightness of Venus.—M. Henry Rey describes in the June number of *L'Astronomie* some measures that he made with M. Comas Sola on the comparative brightness of Venus and Sirius. Taking advantage of a particularly clear evening at Barcelona on March 25 in 1913, when the planet Venus was at her period of maximum brightness, they secured a series of photographs of the planet and Sirius (out of focus) on the same photographic plate. In the case of the latter the size of the image was so adjusted as to be equal to that of the planet. The durations of the exposures were 2, 4, 6, 8, and 10 seconds for the planet, and 25 seconds 1, 2, 3, 4, 5 minutes for the star. A comparison of the discs led to the conclusion that 10 seconds on Venus equalled two minutes on Sirius, or that Venus was twelve times brighter than Sirius. Thus the magnitude of Venus would be 6·72, Sirius being $-1{\cdot}4$. Another communication on the same subject, by M. Salvador Raurich, appears in the same journal, and gives the brightness of Venus as nine times that of Sirius, nineteen to twenty times that of Aldebaran, and five times that of Jupiter.

Causes of Changes in the Rate of a Watch.—There are no doubt many amateur astronomers who depend for their time on watches, and now that wireless time-signals cannot be received, they have to trust to their rates for longer periods than was then necessary. When such watches are taken out of the pocket and hung up or placed on a rest for the night the change in the rate is liable to many vicissitudes. Such variations can amount to a considerable quantity, and an interesting note on this subject appears in the May number of the Monthly Notices of the Royal Astronomical Society, by Mr. J. J. Shaw. In his concluding remarks the author states that "since writing the foregoing, it has been brought to my knowledge that the late Lord Kelvin made some similar experiments with watches," particulars of which were given in his "Popular Lectures," vol. ii., p. 360. The subject is, nevertheless, of such practical importance that attention may be directed to Mr. Shaw's communication. The chief moral to be drawn is, do not hang your watch up on a hook or nail unless precautions are taken to prevent the watch from oscillating. If you do, then an oscillation may be set up, under the influence of the watch's own balance-wheel, which will change the rate from a fraction of a second a day to one of many seconds or even to a quarter or more of a minute.

THE BRITISH SCIENCE GUILD.

THE ninth annual meeting of the British Science Guild was held on Thursday, July 1, the chair being taken by the president, the Right Hon. Sir William Mather. In opening the proceedings, the president expressed regret that owing to weak health Sir Norman Lockyer, chairman of the Executive Committee, and the founder of the guild, was unable to be present. Referring to the presidential address to the

British Association in 1903, on the necessity for the culture of science in all the affairs of life, Sir William Mather remarked:—"I venture to believe that we could claim for Sir Norman Lockyer the character of a prophet, for foreseeing, as he appears to have done, the movements of the world which have come to pass since, and more especially the great need, in regard to English culture and education generally, for more thorough scientific training. Had what he then proposed been carried out the effects at the present time would have been very greatly to our advantage as a nation."

The ninth annual report of the guild was adopted on the motion of Sir Boverton Redwood, seconded by Col. Sir John Young. The report was summarised by Sir Boverton Redwood as follows:—The activities of the guild have been well sustained during the past year, notwithstanding the war; and, in fact, in certain directions the guild has rendered services to the country in dealing with difficulties which the war has created. As in former years, the report reviews the action of the Government in the appointment of Royal Commissions, Departmental and other Committees that deal with matters in which the guild is interested. It is satisfactory to note that some progress has thus been made in enlisting the services of men of science and technologists, and it is still more gratifying to Sir Norman Lockyer and other members of the guild who have long advocated such an action, that the President of the Board of Education is proceeding with the scheme outlined by his predecessor for the co-ordination of higher education, and especially of higher technical education, with the object of developing industries in this country. Under the guidance of Sir Ronald Ross the medical committee, in common with other committees of the guild, has been chiefly occupied with matters arising out of the war. The action taken by the committee in strongly condemning the unpatriotic attempt to throw discredit on the practice of inoculation against typhoid may be specially mentioned. The attention of the Executive Committee having been directed to questions, in connection with science and the State and the encouragement of discovery, raised in Sir Ronald Ross's address to the members of the guild at the annual general meeting of the guild at the Mansion House in May, 1914, it was decided to appoint a special committee to consider and report on the matter, and especially to consider the desirability of increasing the financial support given by the Government for the higher forms of intellectual effort, and adequate remuneration of scientific workers and learned societies for services rendered in connection with Royal Commissions and Departmental and other Committees. This inquiry has not yet been completed, but considerable progress has been made.

In September last, the attention of the Board of Trade was directed to the effect of the war in putting a stop to the import from Germany of glass and glass apparatus, and to the possibility of taking advantage of the opportunity thus afforded of extending the manufacture of glass in this country. In this connection, Lord Moulton, as chairman of the Technical Sub-Committee of the committee appointed by the Board of Trade, referred this matter to the guild for consideration, and the guild deferred it in turn to the Technical Optics Committee. A report was presented stating that proper provision should be made at the National Physical Laboratory for the examination of samples of glass as to their physical and optical properties, and that the director of the laboratory should be approached on the subject. It was also proposed that facilities should be provided for carrying out at the National Physical Laboratory or elsewhere of the research connected with the manufacture of the optical glass referred to in the report; that steps should be taken as speedily as possible to give effect to the previous recommendations of the Technical Optics Committee in the direction of providing facilities for the systematic scientific and manual training in technical optics; and since this training requires time, the committee is strongly of opinion that the question is urgent and that organisation should be taken in hand at once.

Since this report was put in print the Executive Committee has learned with satisfaction that steps have been taken by the Government to give effect to the first two of the recommendations. In regard to the supply of chemical glass apparatus which, prior to the war, had been largely obtained from Germany and Austria, the guild, through the joint action of its Education Committee and Technical Education Committee, has been able to secure from a large number of the principal educational institutions assurances of support to British makers; and has done much valuable work in obtaining information as to the types and sizes of glass apparatus in greatest demand for the guidance of those who are engaged in meeting the present deficiencies in supplies.

Sir Philip Magnus, in moving the election of the Executive Committee and of the Right Hon. the Lord Mayor as a vice-president, said that at no period in our history was it more important than it is now that our country should avail itself of the services of its scientific men. It is absolutely essential that we should avail ourselves of the help which can be given by scientific men in this war, and a very important duty falls on the Executive Committee of this guild to organise or assist in organising these efforts. At the present time we are considering in the House of Commons a Bill described as the Munitions of War Bill. The object of that Bill is to make provision for furthering the efficient manufacture, transport, and supply of munitions for the present war and other purposes incidental thereto. When one looks at the contents of that Bill, the consideration and discussion of which took place a few nights ago on the first and second reading, there is no reference whatever to the assistance which science might be enabled to give to the very objects with which the Bill has been promoted. The whole of the Bill and the discussion in which it was introduced referred simply to the relation of employers to employed, and the condition under which the working classes may be willing to give their assistance.

I have been using my endeavours so far as possible to discover what steps our Government are at present taking to carry out the object to which Sir William Ramsay will refer in his address. It seems to me very desirable that all our departments of State should act in co-operation with each other so as to prevent any overlapping of effort in the endeavours to apply science to the varied requirements of the war, so I asked the Minister of Munitions if he could make a statement as to the steps that have been taken, and are about to be taken, for co-ordinating, for war purposes, the services of men of science, and for utilising the laboratories and workshops of our universities and technical schools for experiments, and for the making of munitions of war or parts thereof; and whether it is intended to establish, as has been suggested, a central committee or bureau for dealing with inventions and practical scientific questions incidental to the operation of the war. The answer I received was fairly satisfactory so far as it goes. It was as follows:—"I am fully alive to the great importance of securing the co-operation of scientific workers throughout the country, and of utilising so far as practicable the laboratories and workshops of our universities and technical schools for such purposes as those alluded to in the question. I am not at present able to make a detailed statement as to the points raised in the last part of the question. I take this opportunity of expressing my appreciation of the valuable help which is already being ungrudgingly given to the Ministry of Munitions by men of science and scientific authorities and institutions."

To a great extent that is a very satisfactory reply, and from all I have been able to learn I feel convinced that great efforts are being made at the present time by the Minister of Munitions and by the advisers of the War Office to utilise the services of scientific men, and I need scarcely point out that the Royal Society is doing all it possibly can with the view of helping the Government in the important objects which it has undertaken, but I am very desirous of urging upon the Executive Committee of the guild that it should use all its efforts to bring about co-operation between these various departments, so that some controlling power may be established which shall be in direct connection with the various Departments of State, and through which, from these departments, shall be forwarded all the various important questions with which those departments have to deal.

After the motion for the election of the Executive Committee and the new vice-president had been seconded by Prof. Perry, and carried by the meeting, Sir William Ramsay delivered an address, the main part of which is subjoined.

THE NATIONAL ORGANISATION OF SCIENCE.

Sixty-three years ago, Dr. Lyon Playfair, afterwards Lord Playfair, gave an address on "Industrial Instruction on the Continent," in which he endeavoured to arouse interest in the applications of science to industry. In it he remarked:—"For many years foreign States, acting upon the facilities for communication, have expended annually large sums in sending highly enlightened men to our country, for the purpose of culling from our experience, and of importing it into their own land; and we see the effect of the experience thus readily acquired, when united with the high development of mental labour, in the rapid growth of new industries abroad. We still hold to mere experience as the sheet anchor of this country, forgetful that the moulds in which it was cast are of antique shape, and ignorant that new currents have swept away the sand which formerly held it fast, so that we are in imminent risk of being drifted ashore. In fact, this is the great question at issue between England and foreign States. With us, there is a widespread jealousy of science, and a supposed antagonism between it and practice. . . . While we continue to rely upon local advantages and acquired experience, we allow a vast power to arise abroad which is already telling against us with wonderful effect."

Reiterated appeals have been made to various Governments in power since that address was delivered; twenty years later, a Royal Commission was appointed under the presidency of the then Duke of Devonshire, which unanimously recommended that a science council should be appointed by the State. Our Science Guild originated as the outcome of a similar appeal made by Sir Norman Lockyer in his presidential address to the British Association, when it met at Southport in 1903.

Our existence as a nation is threatened. Although I am and have been for many years an advocate of compulsory military service, I cannot but admire the response to the call to arms by the Minister of War. But it is not enough. Every man and woman must aid in combating the enemy. Words are incapable of expressing the detestation with which we all view the stupid and vicious methods which the Germans have adopted; but we cannot deny that the German people have been carefully organised, and that it will need every effort on our part, and on that of our Allies, to defeat their armies.

The French Academy of Sciences, at a general meeting on August 4, offered to its Government all its resources in aid of national defence. Committees were immediately constituted, and the Under-Secretary of State for War placed at the disposal of these committees the services of officers equipped with full knowledge of the requirements of the War Office.

On October 29 I wrote an article which appeared in NATURE, from which I may be allowed to quote the following passage:—"There is a class of our fellow-subjects which has yet, so far as I am aware, not been organised. That is the fellows of the Royal, the Chemical, and the Engineering Societies. In their own particular provinces they are the pick of the brain of the country. This war, in contradistinction to all previous wars, is a war in which pure and applied science plays a conspicuous part. Has any attempt been made to co-ordinate the efforts of the devotees of physical, chemical, and engineering science, so that they may work together at what for us is the supreme problem of all—how to conquer the Germans? For if we fail, civilisation as we know it will disappear." This is the first of July, and such an organisation has yet to be created.

Now it is exceedingly difficult to speak openly on this matter; for certain steps have been taken. One, known to the public, is the appointment of Lord Moulton as a general adviser; his efforts were concentrated first on the establishment of a colour industry; and we understand that he has now the task of organising the supply of munitions of war. Doubtless much has been done; but neither the general public nor the fellows of the various scientific societies have any special knowledge of what has been, and what is being, accomplished. If he has consulted anyone, that has been done privately. It is believed that a small committee was appointed to advise on the colour question; but here again we have no definite knowledge. Another fact in public view is the appointment of Mr. Lloyd George as Minister of Munitions. His counsel to the operatives is doubtless valuable. Here, again, a committee is being nominated.

A deputation of the Royal and Chemical Societies, and of the Societies of Public Analysts and of Chemical Industry, had an interview with the President of the Board of Trade on May 6; with him was Mr. Pease, President of the Board of Education. Shortly after, Mr. Pease announced in the House of Commons that he was considering names of members of an "Advisory Council on Industrial Research"; I learn from Mr. Henderson, who has succeeded Mr. Pease in the Education Department, that he is proceeding to the appointment of this Advisory Council.

Letters have appeared from time to time in the Press from fellows of the Royal Society and others urging the centralisation of scientific effort. Prof. Fleming, whose knowledge of wireless telegraphy is second to none, has had no opportunity of helping his country, although it is long since he offered his services; and Prof. Armstrong, on June 21, makes the reasonable assertion that no half-dozen persons have a right to assume that they can do all that is required in any branch of science, and reminds the public that had his suggestion been adopted that the Royal Society should have been grouped, according to subjects, into Grand Committees, we should have been many months in advance of our present position.

It has been necessary to survey what has been done up to now, in order to consider what it is best to do. And I must repeat that the whole energy of every subject of our King must now—at once—be solely devoted to one object: that of helping our soldiers to defeat the enemy. Our Government has missed one great chance; if they had declared cotton contraband of war in January, as they were implored to do from many quarters, in all probability the war would be now nearing its end; the enemy would have run short of propulsive ammunition.

I may be allowed to quote a letter I have received from a distinguished French professor of chemistry, an adviser to the French War Office:—

"Le coton doit être prohibé au même titre que le cuivre. Il est aussi indispensable à la fabrication des munitions que ce métal et, avec les exigences actuelles de la balistique, il ne peut être remplacé par aucune autre matière première pour la fabrication du coton-poudre.

"J'ose maintenant esperer que votre flotte fera bonne garde et qu'elle ne laissera plus passer les nombreux chargements qui s'acheminent vers l'Allemagne par le voie de le Suède, du Danemark et surtout de la Hollande.

"Il est probable que si ces derniers pays avaient pratiqué une vraie neutralité, nous serions bien près de la fin des hostilités et n'aurions plus à déplorer des pertes journalières de milliers de vies humaines."

As it is, cotton is still freely entering Germany through Rotterdam; it is true that a Dutch syndicate is bound under a penalty of 10,000*l.* to exclude it, if delivered to them; but there is good reason to believe that this penalty is ineffective.

It is bad policy to regret what might have been; it is much better to try to devise plans to make up for lost time; and the first essential is organisation. It is notorious that there is little intercommunication between the various Government Departments; many of them are confronted by the same difficulties; many of these difficulties would be overcome if scientific advice were asked for; and the prime necessity at the present moment is a central body of scientific men, to whom the various Government Departments should be compelled to apply for advice and assistance. And more; it should be within the province of such a central organisation of science to propose new means of circumventing the enemy; it should have access to special information, and should be in close touch with all Departments of State, by having State officials as assessors at the meetings of the committees.

Instead of this centralisation, what do we see? Numerous small committees, composed of men who may be perfectly capable, but who are not in the public view; men whose mouths are muzzled, because it has been decided, in each case, to keep their names secret. This, I think, is due to a confusion of ideas; there is no object in preserving secrecy as to the members of such committees; there is every reason that they should regard their deliberations and actions as confidential.

Now, the creation of such small committees by various members of the Government has had the effect of stopping the organisation of men of science. Those who are serving on the committees feel that they would be guilty of a breach of trust were they to take part in the formation of a strong, central body of organised science. Hence various attempts to elicit the views of the fellows of the Royal and other societies have been blocked at the outset. What is the remedy? Let us see if we cannot learn from our neighbours the French; they have a remarkable power of meeting a difficult situation.

I have before me a document headed "République française. Ministère du Commerce, de l'Industrie, des Postes et Télégraphes. Office des Produits Chimiques et Pharmaceutiques." The *directeur* is one of the best-known French chemists, the discoverer of synthetic camphor and the inventor of a process for producing it commercially.

Various "Commissions," or, as we should say, Committees, have been appointed. These are:—(1) Commission on Patents. (2) Commission on Chemical Solvents, Alcohol, etc. (3) Future Commercial Situation of German Works in France. (4) Customs Commission; Customs Union of the Allies. (5) Transport Commission: Rail, River, and Canal, and on the High Seas.

Other special Commissions deal with colours, drugs, general chemical manufactures, including manures, and with synthetic and natural perfumes. These are all in active operation. Each will make a report which will go first before the General Commission, and afterwards their proposals will be brought before the Chambre des Députés—the French Parliament.

Just imagine the state of mind of the permanent officials of our Government Departments were such a scheme forced upon them! It would disturb the even tenor of their way; they would be obliged to do something, instead of carefully classifying all proposals made to them, and putting each into its appropriate pigeon-hole. But they have not yet realised that we are engaged in a war in which ancient practices may have to be superseded.

What are men of science to do? The Chemical Society has begun to organise itself; the Royal Society still hangs fire; other societies, I believe, have made attempts. It must be admitted that they have received scant encouragement. The recent deputation of some societies to Messrs. Runciman and Pease has resulted in the appointment of an Advisory Council of the Board of Education to encourage research. Various eminent men have been asked by Mr. Henderson, Mr. Pease's successor in office, to serve on this Council. It would appear that their functions will be chiefly to encourage education, especially in connection with research—a most excellent object, but surely one which can stand over until this life-and-death struggle is decided. I am glad to learn that it is not proposed to establish more scholarships; they tempt young men to embark on a scientific career for which there is little reward; for many of our manufacturers have not had time to grasp Lord Playfair's aphorism, now more than sixty years old—"It is only experience, aided by science, that is rapid in development, and certain in action."

It is never too late to try to mend; and it is clear that we need expect no initiative from members of our Government. But we might, as scientific men, organise ourselves; and then endeavour to induce the Coalition Government to take some such steps as were taken by the French Government on August 4.

I am much indebted to Lord Sydenham for permission to use a draft of a scheme, which he provided at my request, for the organisation of the Royal Society. It has not yet been submitted to that body, which stands at the head of all our other scientific societies, nor to other societies; but it is certain that each society, after organising itself, would be willing to place its organisation at the disposal of the oldest and premier scientific society of the world. His scheme is as follows:—

"The Royal Society keenly desires to place all its resources of expert knowledge and experience, collective and individual, at the disposal of his Majesty's Government, for the purposes of the war.

"It is also proposed to act as an intermediary between H.M. Government and other learned societies with a view to obtain their co-operation, which, it is certain, will be freely given.

"Already the Royal Society has formed committees for dealing with certain branches of applied science which can be brought to bear upon the operations of war. It is necessary to regularise the position and to extend the sphere of influence of such bodies. In order to carry out these objects without delay, the following measures appear to be necessary:—

"(1) The Royal Society to be formally constituted as an advisory body in regard to scientific questions arising out of the war, and requiring to be dealt with by his Majesty's Government.

"(2) For this purpose the Royal Society would establish a general advisory committee to which all Departments of State would be directed to apply for assistance in regard to such matters as the following:—

"(*a*) New inventions or suggestions involving the application of science to warfare by sea or land.

"(*b*) Any problems arising out of the proved needs of war which call for scientific treatment and investigation.

"(*c*) Improved methods of manufacture, or new manufactures, requiring to be started.

"(3) The duties of the general advisory committee would be:—

"(*a*) To make such subcommittees as are needed to deal with all the above-mentioned matters.

"(*b*) To allocate them either to these subcommittees, or to individual experts, as may seem most efficacious.

"(*c*) To secure co-ordination and to prevent overlapping of work.

"(4) The general advisory committee should also be empowered to make suggestions to the head of any Department of State in regard to questions of applied science.

"(5) The subcommittees would not necessarily consist only of fellows of the Royal Society, but would contain members of other scientific societies, or individual experts, together with representatives, nominated by the Department of State concerned.

"(6) Such representatives would act as intermediaries between the subcommittee and the Department, and would obtain from the latter any information required.

"(7) If, arising out of the war, new processes of manufacture were needed to be begun, or existing processes to be improved or extended, the subcommittee involved would co-operate with the Munitions Department, and would provide such expert knowledge as might be required.

"(8) When special experiments, lying beyond the resources at the disposal of, or accessible to, the Royal Society, became necessary, funds should be made available *ad hoc*, either by the Treasury, or by the Department concerned."

It will be observed that Lord Sydenham's draft scheme deals only with exigencies of war. But is it too much to hope that if and when peace comes, the organisation would not be allowed to lapse? This will not be the last war; we have learned, in the crucible of fire, that we must be prepared. Nor is what we usually term "war" what is most to be dreaded. It is the insidious advance by fair means or foul means of our enemies the Germans to obtain a monopoly of all fields of human endeavour. That nation is organised for that purpose, and this war is merely one attempt, and let us hope a fruitless attempt, to obtain world-wide dominion.

May I conclude by quoting again from Sir Norman Lockyer's presidential address?

"Without such a machinery [as that of a Scientific National Council], how can our Ministers and our rulers be kept completely informed on a thousand things of vital importance? Why should our position and requirements as an industrial and thinking nation receive less attention from the authorities than the head-dress of the Guards? How, in the words of Lord Curzon, can 'the life and vigour of a nation be summed up before the world in the person of its Sovereign' if the national organisation is so defective that it has no means of keeping the head of the State informed on things touching the most vital and lasting interests of the country?"

In the course of his remarks while moving a vote of thanks to Sir William Ramsay for his address, the president said: Though some of us may differ from Sir William as to the likelihood of another war as great as this, on one point we are all bound to agree with him, namely, that there should be prompt national organisation of all the scientific capacity we possess; co-ordination, and supreme control by a council—it need not consist of more than a dozen men, whose duty it should be to apply scientific results to the war in every department. There is no doubt in the world that we can have an organisation in Great Britain equal to anything which the Germans possess if we will only make up our minds to do it. Our Parliamentary Committees and other committees dealing with most important aspects of this war will not succeed in doing anything of real importance to our present needs unless they work through such a council as has been suggested. From that point of view I think the British Science Guild might be of service. We must spare no effort to impress upon the Government and the public that the course proposed by Sir William should be taken at once.

Sir Archibald Geikie, in seconding the vote of thanks, said:—It is a painful history—the history of the indifference of the State to science and our country. I throw my mind back to the time when I heard Sir Lyon Playfair give that address from which Sir William has quoted, and I know that every word then said was true. I dare say that since that time some of the indifference—I would almost call it the antipathy—on the part of the official mind towards science has altered a little for the better, but there is still plenty to be done. It is not all the fault of Governments. They themselves have to work against the dead-weight of this incubus of indifference which goes right through society. The Royal Society has been mentioned, and I am proud of its history. As you are aware, the Royal Society is actively at work at present, the council having been converted into a war committee so as to devote the whole of its efforts to war matters. If there is to be some central committee dealing with scientific matters, I am sure there could be no more efficient centre than the council of the Royal Society.

The proceedings terminated with a vote of thanks to the chairman, proposed by Sir Ronald Ross, seconded by Sir A. Phillips, and carried unanimously.

A CONSULTATIVE COUNCIL IN CHEMISTRY.

WE print below a letter issued by the president and council of the Chemical Society with the view of assisting the Government to bring the war to a successful conclusion. Fellows of the society are invited to offer suggestions likely to be of value to our armed forces, to state in what branch of work they consider they can be of most use to the country at the present juncture, and what facilities they can offer either as regards laboratory accommodation or time available for voluntary work on national services. The council has constituted itself a consultative committee to consider suggestions and inventions placed before it; and its action should be the means of placing at the disposal of the country an effective body of expert opinion. The co-ordination and organisation of the various branches of chemical science and their application are of the utmost importance to the Empire; and the efforts being made by the Chemical Society with these ends in view will give satisfaction to all who realise the difficulty of the problems before us.

Whilst much has been done to assist the Government in many of the scientific problems arising from the war, the technical knowledge and talent of the nation are not being utilised to their utmost. No one knows what is being done, and there is no way of finding out what problems in chemistry, physics, and engineering are urgently requiring solution. The practical man with his problem has no means of getting in touch with the inventor who delights in grappling with practical difficulties, or with the man of science who can bring his expert knowledge to bear upon it. Further, it is realised that an overworked War Office is not the place at which original methods or devices can be given adequate and competent consideration.

In order to remedy this unsatisfactory condition of affairs some system for organising and co-ordinating the inventive power of the country must be devised. With the object of doing this for chemistry and its allied sciences, the Chemical Society has put forward its scheme. The society will have the co-operation of committees specially qualified to deal with individual problems; each of these committees will consist of eight members, of whom six will be appointed by one of the kindred societies, while the other two will be members of the council of the Chemical Society, to form a link with it as the central body which will forward inventions or suggestions and the reports upon them to the proper authority. For dealing with questions of the general policy to be pursued, both during and after the war, a committee thoroughly representative of chemical opinion in all its branches will, we understand, be appointed immediately.

The Chemical Society,
Burlington House, Piccadilly,
London, W.

DEAR SIR,—In March last the Council of the Chemical Society presented to the Prime Minister a memorial on "The Position of the Chemical Industries" in this country and asked him to receive a deputation from the Society to explain in greater detail the opinions set forth therein. A similar memorial had also been presented by the Royal Society, and on May 6th the Presidents of the Boards of Trade and Education received a joint deputation from the two societies. The deputation[1] assured his Majesty's Ministers of the loyal desire of the Fellows of both Societies to assist the Government and promised their hearty co-operation in all that could be done to utilise the great but latent chemical talent of the nation.

As the war proceeds, the paramount part which chemical science is playing and is destined to play in the present struggle becomes daily more evident to everyone, and in pursuance of the assurance given to the President of the Board of Trade, the Council has constituted itself a Consultative Body which will meet at frequent intervals to consider, organise, and utilise all suggestions and inventions which may be communicated to it, and will report on the same to the proper authorities. In this work it will have the assistance of Committees specially qualified to deal with individual problems, the nature of which will doubtless be very diverse. The Council is of opinion that much can be done in this way to relieve the overwrought Government Departments of work which would probably appear less complex to such Committees of chemical experts.

[1] A report of the proceedings will appear in the Transactions for July.

This Consultative Body having now been formed, the President and Council invite the Fellows of their own and kindred societies to forward *in strict confidence* suggestions and inventions for its careful consideration. However trivial some of these suggestions may appear if taken alone, it is always possible that when brought into correlation with others they may lead to results of great value, and it is this process of correlation and subsequent presentation to the suitable Government authorities which the Council has in view.

All suggestions should be addressed to the Council of the Chemical Society, Burlington House, London, W., and will be regarded as confidential by the Council, which feels that it may rely on the loyal and energetic co-operation of the Fellows in this attempt to render assistance to the Empire.

It is of great importance that the Council should know on whom it can rely for help and the nature of the services each Fellow can render; it will be of considerable assistance, therefore, if you will kindly fill in and return the form attached.

Issued by the authority of the Council,
ALEXANDER SCOTT,
President.

July 1, 1915.

THE RESEARCH DEFENCE SOCIETY.

HAPPY are those scientific societies which have not been thrown out of work by the War, but have found something that they can do for the country in its time of suffering. The Research Defence Society, if its only occupation were to denounce and oppose anti-vivisection, would have been well-nigh useless since last August; none of us, now, is thinking of this old adversary of science. But the Research Defence Society found plenty of work; it set itself to the business of explaining and commending, to audiences of soldiers, the protective treatment against typhoid fever, and, at its annual general meeting on June 30, it was able to give a good report of this part of its work.

Last October, with the approval of the War Office, it published a four-page leaflet, "Protection Against Typhoid Fever." Consignments of this leaflet were sent, with the help of the War Office, to be distributed through the Army. Many scientific or philanthropic bodies also helped in the work of distribution. About 350,000 copies of this leaflet have already been issued. It has been translated into French, and 20,000 copies of this translation have been distributed, by the help of M. Maton, Belgian Military Attaché in England. Copies of the leaflet can be had on application to the hon. secretary of the society, 21 Ladbroke Square, London, W. The society also has given a great many lectures to soldiers, illustrated with lantern-slides and moving pictures, on wound infection and on the infective diseases, with special reference to the protective treatment against typhoid fever.

The opposition to this treatment, happily, is nearly over. It would not stand against the facts of the case, and there is an end of the matter. Mr. Tennant, in the House of Commons, on July 1, gave the latest figures relating to it, and they leave nothing to be said. But there is another disease, tetanus, which has been fought, and beaten, among the Expeditionary Force, by a protective treatment. None of us can soon forget the terror of the news, early in the war, that tetanus was frequently occurring. We feared lest it should be again as dreadful as it was in the American Civil War. Everything was in its favour: the soil was heavily charged with tetanus-germs, many of the wounds were deeply lacerated, and the vast majority of them were septic. It is impossible to doubt that the protective use of tetanus antitoxin is the principal cause of the disappearance of tetanus among our wounded; there are but very few cases of it now. Sir William Osler, at the annual meeting of the Research Defence Society on June 30, rightly emphasised this point; it does not need to be emphasised for those of our readers who are medical men and have watched cases of tetanus.

After the meeting Dr. Andrew Balfour gave a demonstration of the protective treatment against typhoid, showing, with admirable ingenuity, how completely the resistance of the body to invading germs may be described in terms of human warfare. Not all men of science are skilful in the use of parables, but he is.

Some day, those of us who live long enough will be able to read the medical and surgical history of the present war. It has been taken in hand by many writers of authority, and it will be fine reading. It will interpret to us one of the noblest records of science in practice. Interpreters of science, popularisers of science, are always useful, and the Research Defence Society has certainly done useful work by interpreting and popularising the methods and the achievements of modern physiology and pathology.

FERROMAGNETISM AND THE A2 TRANSFORMATION IN IRON.

RECENT years have witnessed a remarkable concentration of experimental research on the critical point A2 in iron. Moreover, whereas up to the year 1904 investigations of this character were carried out chiefly by metallurgists and engineers, since that date there has been a most welcome entry of physicists and physical chemists into this field of research, who in virtue of their different training and outlook have investigated the problem from a somewhat different point of view, and, it must be granted, by more rigorously scientific methods. The paper by Mr. Kotaro Honda, of the Imperial Tohoku University, Japan, on the nature of the A2 transformation in iron, presented at the spring meeting of the Iron and Steel Institute in London, is a valuable contribution by a physicist who has made a special study of this question for a number of years.

Broadly speaking, there are three views of the nature of the A2 transformation which the author summarises in the following language:—

"(1) The transformation is an allotropic change (α to β) occurring at a definite temperature, or at least within a small range of temperature; (2) β-iron is not an independent phase but a solid solution of α and γ iron; (3) the transformation is not an allotropic change but an intermolecular change taking place in the α phase within a considerable range of temperature."

The first view is historically the oldest, and is particularly identified with the late M. Osmond. It was warmly adopted by Roberts-Austen and his co-workers, and is apparently still supported by Tammann, Howe, Sauveur, Burgess, and Rosenhain, although it raises several difficulties in explaining the facts actually observed. The second view was enunciated in 1912 by Benedicks, but although at first sight a promising case was made out, and it appeared to be supported by a test research published by Carpenter in 1913, it is in conflict with many well-established facts, and has been practically abandoned. The view that A2 is not an allotropic or phase change was first put forward by H. Le Chatelier, and shortly afterwards by P. Weiss. It numbers among its additional supporters at the present time Benedicks, Hadfield, Carpenter, Edwards, McCance, and Honda. It is the most modern view of the nature of the transformation.

Mr. Honda's experimental contributions to the study of the nature of the A2 critical point as revealed in his paper relate to (1) the thermal changes associated with the transformation; (2) magnetisation at high temperatures; and (3) magnetic expansions at high temperatures. With respect to the first-named they confirm what has long been known, viz., that the heat evolution on cooling, and heat absorption on heating corresponding to the A2 transformation take place over a wide range of temperature, at least 100° C., although the greater part is evolved or absorbed within 30–40° C. The complete range, however, is probably considerably more than 100° C. A transformation extending over so wide an interval cannot properly be regarded as an instance of "one-phase allotropy." Neither is it correct to speak as Burgess and Crowe do of the temperature at which $dq/d\theta$ is a maximum, as the critical point or range. The author regards the temperature at which the heat evolution begins on cooling, or the heat absorption ends on heating, as the critical point, and uses the expression in this sense. It is also the temperature at which ferromagnetic iron becomes paramagnetic, or *vice versâ*.

The most important section of Honda's paper is that dealing with magnetisation at high temperatures. Many metallurgists hold the view that the magnetisation of ferromagnetic metals undergoes an abrupt change at their critical points, but this is seldom the case. In fact, the course of the temperature-magnetisation curves changes markedly with changes of strength in the magnetising field, and Honda's experiments on pure iron, nickel, and various kinds of steels show this clearly. In a very weak field the magnetisation of iron and nickel increases with temperature at first slowly, and then very rapidly, and after reaching a sharp maximum it falls extremely quickly at the critical temperature. If the strength of the magnetising field is augmented this effect of increasing magnetisation becomes continually less. In a field of several gauss the magnetisation remains constant up to the critical point and then falls very rapidly. With further increase of field the magnetisation begins gradually to decrease from a temperature which is lower as the field is stronger, and in a field of several hundreds the magnetisation begins gradually to decrease from the room temperature. In all cases the effect of temperature on magnetisation is twofold, and the observed change of magnetisation is the sum of these two effects. The first effect is specially conspicuous in weak fields, and becomes continually less as the field is increased. It is similar to the well-known mechanical tapping on magnetisation, which it increases, the thermal agitation playing the part of mechanical shocks. The second is a reversible effect, and always acts in diminishing magnetisation. By incessant thermal impacts the molecular magnets execute rotational vibrations about their mean orientations, and the mean magnetic effect is diminished by the vibration. It is easy to see therefore that the decrease of magnetisation increases with the amplitude of rotational vibration—*i.e.* with rise of temperature. In very strong fields the first effect no longer obtains and there exists chiefly the second reversible effect of temperature.

Mr. Honda has concerned himself only with the latter, which is much the more important of the two. With respect to iron, his conclusion is as follows:— "In strong fields when the irreversible thermal effect is negligible the magnetisation begins to diminish from the lowest temperature, the change per degree of temperature increasing at first gradually but becoming always greater as the critical temperature is approached. If the change of magnetisation indicates that an intermolecular change is taking place in the substance which at the same time manifests itself as the evolution or absorption of heat, then the two quantities q and I must vary parallel to each other. Strictly speaking, therefore, the heat should begin to be absorbed from the lowest temperature in the case of heating, though its amount is negligibly small, except in the A2 range."

Mr. Honda also tested the question whether the magnetic and thermal changes are really different aspects of one and the same transformation taking place in the substance. This was done by making simultaneous observations of the magnetisation and the heat evolutions or absorptions in the critical range. Both for iron and nickel it was found that the temperature of the beginning of the magnetic "transformation" on cooling, and that of its ending on heating, coincide well with the corresponding temperatures of heat evolution and absorption respectively. In other words, the critical temperature as determined magnetically agrees with that as determined thermally.

The final section of the paper contains a summary of the author's theory of ferromagnetism, according to which the shape of the molecules of a ferromagnetic substance is nearly spherical, whereas in a paramagnetic substance the molecule has an elongated or flattened form. The transformation of a ferromagnetic to a paramagnetic substance at high temperatures is explained as a consequence of the gradual deformation of the spherical molecules with rise of temperature. The paper is one which should certainly be studied by those who are interested in the A2 transformation, not only in pure iron but also in steels.

H. C. H. C.

RECENT MARINE RESEARCHES.

THE report of the Danish Biological Station for 1914 contains two papers describing investigations which have been carried out at the station with a view of determining the importance of the detritus derived from the decay of Zostera and other sea-weeds as a source of food for the invertebrate bottom fauna in Danish waters. The idea was recently put forward by Dr. C. G. Joh. Petersen that in these waters this organic detritus is of much greater importance than the plankton. P. Boysen Jensen, in a paper entitled "Studies concerning the Organic Matter of the Sea Bottom," deals with the question from a chemical point of view. By determination of the quantity of pentosan in proportion to the amount of organic matter it was found that Zostera was relatively far richer in pentosan compounds than the plankton organisms. The organic matter of the sea bottom occupied an intermediate position. The author concludes that in the more sheltered waters the organic matter of the sea bottom is almost exclusively derived from Zostera, whilst in more open waters plankton organisms are possibly of some importance.

The second paper is by cand. mag. H. Blegvad, on food and conditions of nourishment among the communities of invertebrate animals found on or in the sea bottom in Danish waters. The stomach contents of a great many animals from different localities have been studied, but unfortunately the discussion of the observations is somewhat illogical and unbalanced, so much so that it is difficult to avoid the fear that a certain amount of unconscious bias may even have crept into the observations on which the discussion is based. The author summarises his conclusions as follows:—"Detritus forms the principal food of nearly all the invertebrate animals of the sea bottom, next in order of importance being plant food from fresh benthos plants. The value of the living phytoplankton in this connection is absolutely minimal, amounting in any case to nothing more than an indirect significance through the medium of the plankton copepods."

A distinct advance in the study of the question of the determination of the age of fishes by the markings on the scales has been made by O. Winge in a paper on the value of the rings in the scales of the cod as a means of age determination, illustrated by marking experiments (*Meddelelser fra Kommissionen for Havundersøgelser*, ser. Fiskeri, Bd. iv., No. 8). The work is based chiefly on material obtained from cod which were marked and liberated by Dr. Johs. Schmidt in the neighbourhood of the Faroes and of Iceland. Samples of the scales were taken before the cod were liberated, and again on their recapture, and the two have been compared. Considerably more than half the cod marked were recaptured, some of them after an interval of a year or more. A novel and very convincing method of recording the results of the examination of the scales has been used. The lengths of the individual sclerites on a line from the centre to the periphery of the scale have been measured, and the measurements recorded in the form of curves. These curves bring out with great clearness the difference between the summer and winter growth. The otoliths of the fish have also been studied, and the author finds that a very high degree of uniformity exists between the growth of the scales and that of the otoliths, both exhibiting growth rings by which the age of the cod can be determined.

In a paper entitled "The Salinity and Temperature of the Irish Channel and the Waters South of Ireland" (Fisheries, Ireland, Scientific Investigations, 1913, vol. iv. [1914]) Mr. Donald J. Matthews gives an account of the hydrographical investigations which were carried out by the Irish Fisheries Department between February, 1903, and May, 1912. The results are based chiefly on observations made on quarterly cruises, which took place in February, May, August, and November, supplemented by temperature records and salinities obtained at more frequent intervals from lightships. An excellent series of charts and sections is given setting forth the mean surface and bottom temperatures, and salinities for each of the months February, May, August, and November, and for the whole year. The saltest water enters the Irish area between Land's End and the Scilly Islands, and this current of salt, warm water is derived from a current which has already entered the English Channel from a south-westerly direction. This salt, warm current gives rise to a peculiar cyclonic circulation in the southern entrance of the Irish Channel, which may prove to be of considerable biological importance. The author considers it possible that a layer of high salinity water, traces of which are met with off the south-west of Ireland, may be connected with the salt intermediate layer which flows out of the Mediterranean into the Atlantic, and has previously been found far to the northwards of the Straits of Gibraltar. A salinity maximum which occurs off the south-west of Ireland in May is perhaps due to this Mediterranean water. The paper concludes with a discussion of the annual temperature changes in deep water.

THE FIFTIETH ANNIVERSARY OF THE WORCESTER POLYTECHNIC INSTITUTE, MASS.

THE Worcester Polytechnic Institute celebrated the fiftieth anniversary of its foundation on June 9, its charter having been signed on May 9, 1865, by John A. Andrew, the war governor of Massachusetts. There were present representatives from eighty universities and colleges, as well as invited guests eminent as statesmen, soldiers, and engineers. The dominant note of the occasion was not so much that of rejoicing over the half-century of progress or that of greater enthusiasm for training in efficiency, but rather that of consecration to the task of training young engineers for their highest service to mankind and to the country.

The institute owes its origin to a gift of 100,000 dollars from John Boynton, supplemented by another gift of 50,000 dollars from Ichabod Washburn. The fundamental idea of the latter was a commercial shop in which students should find laboratory practice in connection with the academic training necessary to make of them engineers and chemists. As Mr. Boynton said, "The benefits of the school are not to be confined to the theories of science, but as far as possible they shall extend to the practical application of its principles in the affairs of life." The shop was regarded as an experiment, but it has turned out to be successful, both as an educational department of a college, and as a successful commercial venture. At first, the opinion was widespread that the school would become a place for educating mechanics and foremen, on account of a peculiar apprenticeship system that prevailed in the early years. It has developed into a professional school for applied science, giving the degrees in engineering and in chemistry. The shop has taken its place as a natural and practical laboratory within a college, exactly as the clinic or hospital may be associated with the medical school. Its organisation is permanent, and it would remain as a manufacturing establishment if every student left the school. The students therefore do not take an essential part in manufacturing, but they use a large part of the shop as their laboratory in the science of manufacturing. The term "scientific management" is vague, but the essential parts of that management which teaches a young man all of the elements, including the actual work, the organisation, the accounting, and the cost systems, are found in the Washburn shops.

The addresses of the celebration laid especial emphasis on the higher education of men for applied science, using the Worcester Polytechnic Institute as a good example of what may be accomplished in that direction. The speakers on June 9 were Mr. A. Lawrence Lowell, president of Harvard University; Dr. John A. Brashear, president of the American Society of Mechanical Engineers; Hon. David I. Walsh, governor of the State of Massachusetts; Hon. John H. Weeks, Senator for Massachusetts; Howard Elliott, president of the New York and New Hampshire Railways; Major-General Leonard Wood, former chief of staff of the United States Army; Ira N. Hollis, president of the Worcester Polytechnic Institute, and others.

President Lowell's address was significant in the text of his subject. "The thing that abolished slavery," he declared, "was not so much the change in morals as it was the change in the control of the forces of nature, without which the change in morals could not have taken place. This enlarged control of the forces of nature is what has made it possible for us to live in modern civilisation. The threatened exhaustion of natural resources and the gigantic destruction of human life and of wealth in the world conflict presents a challenge as to whether we have intelligence enough to prevent the serious set-back to civilisation that may follow. In meeting this challenge, large trustworthiness must be placed upon the schools of applied science."

General Wood's speech related almost wholly to the establishment and maintenance of a citizen soldiery behind a small regular army in the United States. He commended the example of Switzerland as a country effectively prepared against war, securing a maximum of defence while avoiding a great military burden, the diversion of the people from their ordinary business, and the sacrifice of their ideals of democracy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LEEDS.—The following honorary degrees were conferred at a Congregation held on July 3:—*Doctor of Laws*: Dr. David Forsyth, headmaster of the Leeds Central High School. *Doctor of Science*: Mr. Harold W. T. Wager, F.R.S., one of H.M. Inspectors of Schools, who began his professorial career at the Yorkshire College, and is distinguished by his researches in cytology and other biological fields. *Master of Science*: Mr. T. H. Nelson, of Redcar, a distinguished ornithologist, author of "The Birds of Yorkshire"; Mr. W. Denison Roebuck, joint author of "Handbook of the Vertebrate Fauna of Yorkshire"; Mr. T. Sheppard, curator of the Hull Museums, author of "Geological Rambles in East Yorkshire," "The Lost Towns of the Yorkshire Coast," and many geological and archæological memoirs; Mr. J. W. Taylor, author of a "Monograph of the British Land and Freshwater Mollusca"; Mr. J. G. Wilkinson, past-president of the Leeds Naturalists' Club, distinguished by his extensive and exact knowledge of the structure of plants, though blind; Dr. T. W. Woodhead, lecturer in biology at the Technical College, Huddersfield, hon. secretary of the Yorkshire Naturalists' Union, and author of various biological memoirs.

OXFORD.—The Halley lecturer for the year 1916 is Prince Boris Galitzin, professor of physics in the Imperial Academy of Sciences, Petrograd. The subject of the discourse is not yet announced.

It will be remembered that at the time of the appointment of the present Waynflete professor of chemistry, Prof. W. H. Perkin, F.R.S., the University decided on the erection of a new chemical laboratory. The building, designed by Mr. P. Waterhouse, is now nearly finished. It occupies a site in the south-west angle of the Parks, close to the University Museum, and has a frontage in South Parks Road. The expense of the actual building was largely provided by the Endowment Fund presided over by Lord Curzon, as Chancellor of the University, and also by a timely and generous donation of 5000*l*. from Mr. C. W. Dyson Perrins, formerly of Queen's College. But Mr. Perrins's munificence has not stopped here. He has lately offered to present to the University a further sum of 25,000*l*., of which 5000*l*. is to be applied to the equipment of the laboratory, and the remaining 20,000*l*. is to form a permanent endowment fund for maintenance of the laboratory and for the encouragement of research and instruction in chemistry. The University is thus relieved from anxiety about the upkeep of the department—a matter which is frequently lost sight of by benefactors. There is now every prospect that the new laboratory will open in October next under the happiest auspices, and that the wise provision made by Mr. Perrins for research will bear ample fruit in the future.

BY the will of the late Alderman Owen Ridley, University College, Reading, receives 1000*l*. for the building or equipment of new college premises, 250*l*. for the assistance of necessitous students, and 200*l*. for prizes for evening class students.

WITH the issue of the *Athenæum* for July 3 is published the first instalment of a Subject Index to Periodicals, which our contemporary is undertaking at the request of a committee appointed for the purpose by the Library Association. To begin with, the progress of science and technology in 1915, with special reference to the war, is being indexed. We welcome this attempt to provide a much wanted guide to current literature, and trust that with competent scientific assistance a comprehensive and representative index will shortly be forthcoming.

AT the last meeting of the council of the University College of Wales at Aberystwyth it was announced that Mr. S. G. Rudler has founded a scholarship in memory of his brother, the late Mr. F. W. Rudler, who was professor at the college from 1875 to 1879, before taking up his work at the Royal School of Mines. Mr. Rudler has also allowed the college to acquire at a small cost the collection of scientific instruments, minerals, fossils, gems, and curiosities, and the library formed by his brother during a period of fifty years. The library includes not only standard works on geology, but also a collection of 3000 pamphlets on geological and kindred subjects.

THE issue of *Science* for June 18 announces the following gifts to American colleges. Two anonymous gifts of 30,000*l*. and 20,000*l*. to the Massachusetts Institute of Technology for dormitories; for funds to construct the mining building some 45,000*l*. has been offered by Messrs. C. Hayden, T. Coleman du Pont, and S. Pierre du Pont, past and present presidents of the du Pont de Nemours Powder Co. Mr. Coleman du Pont, with a gift of 100,000*l*., made the purchase of the technology site in Cambridge possible. Messrs. C. A. Stone and E. S. Webster have undertaken to provide a residence for the president. Mr. J. R. Lindgren, of Chicago, has bequeathed half his estate, valued at 210,000*l*., to Northwestern University, subject to certain life annuities. From the same source we learn that the sum of 6000*l*. has been given to Dalhousie University, Halifax, N.S., towards the endowment of a chair of anatomy, and it is stated that in the near future the sum will be doubled.

THE Calendar for the Imperial University of Tokyo is instructive reading, tracing as it does the development of a highly organised University where scientific research lives and thrives from what was, a generation ago, little more than a high-class school. There are six colleges—law, medicine, engineering, literature, science, agriculture—with a staff of professors, assistant-professors, and lecturers numbering close on 400, who teach and train some 1500 students. Barely 5 per cent. of these are students of science, while the law students number nearly 40 per cent. of the whole. Some idea of the specialisation attained may be gained from the statements that there are twenty-six professorial chairs to about seventy students in the College of Science, and that of these there are four chairs in mathematics, three in physics, two in theoretical physics, four in chemistry, three in zoology, three in botany, two in geology, and one each in mineralogy, geography, seismology, and anthropology. The journal of the college, which began publication in the year 1887, has now reached its thirty-fifth volume, and contains many important memoirs, chiefly in English, on all branches of pure science, contributed for the most part by the Japanese themselves. With the exception of the Law College, all the other colleges also publish memoirs or bulletins. This is a remarkable record, and shows that the ideal aimed at is being successfully maintained.

SOCIETIES AND ACADEMIES.

LONDON.

Challenger Society, June 30.—Dr. G. H. Fowler in the chair.—C. Tate **Regan**: The fishes of the Macquarie Islands. Attention was directed to the importance of these little-known islands from a faunistic point of view, lying as they do near the boundary between the Antarctic and Subantarctic zones.—Dr. W. T. **Calman**: The distribution of Antarctic Pycnogonida. This paper was based on a study of the collections obtained by the British Antarctic (*Terra Nova*) Expedition, 1910. No fewer than forty-three species were obtained, of which eleven will be described as new. These results accentuate the remarkable richness of the Antarctic Pycnogonidan fauna and its preponderance over that of the Arctic seas, regarded until recently as the headquarters of the group. Only a few species have been definitely proved to have a circumpolar distribution, but it is certain that the number will be greatly increased by further collecting, although some cases of more restricted range (*e.g.* the species of Decolopoda) are already known. The isolation of the fauna is shown by the fact that not more than two or three species are definitely known to extend, in shallow water, into the Subantarctic zone.

DUBLIN.

Royal Dublin Society, June 22.—Prof. W. Brown in the chair.—W. D. **Haigh**: A method for the estimation of hygroscopic moisture in soils. In the ordinary method of determining the hygroscopic moisture in soils difficulties occur from the fact that other vapours besides hygroscopic water may be given off by the soil when heated. The power of calcium carbide to act as a desiccating agent has of recent years been put to practical use. It has been applied to the determination of moisture in wool, explosives, etc. Calcium carbide possesses the advantage that the only ordinary substance which will react with it is water, and the acetylene evolved can be readily measured. The method consists of mixing the soil with an excess of finely powdered calcium carbide. The reaction is complete in a few minutes, and the volume of acetylene is measured in a nitrometer over mercury. It has been found that the results obtained are consistent and agree fairly closely with those obtained by heating in the oven; but in an ordinary soil the carbide determination is generally from 0·1 per cent. to 0·3 per cent. lower than that obtained in the oven. This has been found to be due to the presence of volatile material other than water vapour in the soil, such material being included in the reckoning with the hygroscopic moisture in the ordinary method of determination.—Dr. J. H. **Pollok**: The presence of bromine in the salt lagoon at Larnaca, Cyprus. The lagoon is about three square miles in area and is situated about one mile from the port of Larnaca, on the southern shore of the island. In the winter the lagoon fills either by infiltration or otherwise, and during the hot months of summer evaporates almost to dryness, leaving a deposit of excellent salt, from which the Government derives a considerable revenue. At the time of greatest concentration, towards the end of August, there is a pool of mother liquor in the centre of the lagoon, having a width of 1800 ft., a length of about 3600 ft., and an average depth of about 3 in., giving an aggregate of about 60,000 cubic yards, or, say, 40,000 tons of liquor. The latter was found on examination to consist of an almost saturated solution of magnesium chloride, together with a small proportion of magnesium bromide. On estimation the liquor gave 5·7 grams of bromine per litre, which is equivalent to about 10 lb. weight per ton. Owing to the war there is at present a very serious deficiency in bromides, and even in magnesium salts, the supplies of which have hitherto been largely derived from Stassfurt, Saxony. The new supply from Cyprus should go a long way to diminish the present shortage.

EDINBURGH.

Royal Society, June 7.—Sir T. R. Fraser, vice-president, in the chair.—Prof. Cossar **Ewart**: Development of the horse during the third week. Much progress had been made during the last fifty years in working out the pedigree of the horse from the fossil remains of its ancestors; but with the exception of the attempt made by Hausmann in Hanover some eighty years ago no systematic study had been made of the development of the living horse. As early as 1870 it had occurred to Huxley that strong evidence of the fact of evolution would be forthcoming if it were proved that the modern horse passed through a hiparion or three-toed stage during development. He failed in his search, not because it did not exist, but because it appeared much earlier than he had expected. Later Bonnet and Martin had both described embryos which were believed to represent the stage reached at the end of the third week; and Bonnet concluded that a twenty-one days' plastocyst might vary from 13 to 35 mm. in length. An exhaustive inquiry had led Prof. Ewart to the conclusion that Bonnet's 13 mm. plastocyst represented the stage reached on the fourteenth or fifteenth day of gestation, that the age of Martin's plastocyst was seventeen or eighteen days, and that a twenty-one days' plastocyst measured not less than 50 mm., or 2 in. These conclusions were supported by some of Hausmann's figures. Many other details were given of the developmental changes which took place during the third week, the peculiarities in the Equidæ being accentuated by comparison with sheep embryos at like periods in the life-history. A magnified model which had been reconstructed by Dr. A. Gibson from Prof. Ewart's sections was exhibited and described by Prof. Robinson.—Prof. **Whittaker**: The functions which are represented by the expansions of the interpolation theory. It is well known that there is an indefinite number of functions the values of which at points at finite intervals are the same as those of a given function. These being called *cotabular functions*, it is shown that there is a certain function belonging to the cotabular set which is represented by a well-known expansion in the interpolation theory. This function is called the *cardinal function*. Its properties are investigated, and a formula is given by which it may be constructed when any one function of the cotabular set is known.—Prof. A. E. **Letts** and Miss Florence W. **Rea**: A modification of Pelouze's method of determining nitrates.—Frank L. **Hitchcock**: Quaternion investigation of the commutative law for homogeneous strains. It has long been known that strains with three different roots are commutative only when the directional roots in the one are parallel to those in the other. When two roots are equal the law of commutation is not the same. Various cases were classified.

PARIS.

Academy of Sciences, June 28.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The drawbacks of Fourier's solution in a trigonometric series for the calculation of the cooling of the earth's crust; and other methods of carrying out this calculation.—C. **Guichard**: The W congruences belonging to a complex of the second order. Case where the equation in S has a double root.—D. **Eginitis**: Observations of the Mellish comet made at the Observatory of Athens with the Doridis equatorial. Positions are given for May 5, 10, 11, 12, 14, 15, 19, and 20.—Maurice **Fréchet**: The definition of an integral extended to an abstract ensemble. An extension of Radon's definition of an integral.—L. **Tschugaeff** and N. **Wladimiroff**: A new series of compounds of tetravalent platinum. The chloride of the base $(Pt.5NH_3Cl)(OH)_3$, or $(Pt.5NH_3Cl)Cl_3$, has been prepared by the action of liquid ammonia upon ammonium chloroplatinate at the ordinary temperature. The carbonate and sulphate of the new base are nearly insoluble in water, and only three atoms of chlorine are removed by silver nitrate in boiling solutions.—Fernand **Camus**: The mosses found in the stomach of a mammoth.—Artatnet de **Vevey**: Sun cures. An account of the diseases cured or ameliorated by sun treatment. The method proposed by the author has been used in the neighbourhood of Paris for twelve years. G. **Tizzoni** and P. **Perrucci**: Determination of the immunising and curative value of antitetanic serum. It is pointed out that there is a complete parallelism between the protective action of an antitetanic serum and its curative effect for tetanus: these two properties of a serum are not parallel with the antitoxic power *in vitro* of the same serum. From the physiological point of view it is probable that the mechanism of the action of antitetanic serum upon strychnine is identical with its action upon tetanotoxin. A method is proposed and given in detail for utilising strychnine for the standardisation of commercial preparations of tetanus antitoxin. F. **Bordas** and S. **Bruère**: Contribution to the study of the phenomena of putrefaction. A suggestion for the use of appropriate ferments for hastening the decomposition of dead bodies.

CALCUTTA.

Asiatic Society of Bengal, June 2.—H. C. **Das-Gupta**: Palæontological notes from Hazara. The author has described a few fossils obtained from the Triassic, Jurassic, and Tertiary beds of Hazara, and these fossils include one new species of Corbula (*C. middlemissi*) and another new species of Nautilus (*N. hazaracnois*).—Bimala Charan **Batabyal**: Dakshindar, a godling of the Sunderbuns. Dakshin Rai is a sylvan godling extensively worshipped in the districts in the neighbourhood of the Sunderbuns to scare away tigers. The procedure in his worship is the same as that of Ganapati. It seems to be a relic of aboriginal rites incorporated at a later period into Hinduism. A description of the idol is given with photographs.—Sarat Chandra **Mittra**: North Indian folk medicine for hydrophobia and scorpion sting. The author describes several charms and nostrums employed by the village *ojhas* or medicine men of northern India for the cure of hydrophobia and scorpion sting. He also publishes the texts, with translations and remarks, of two verbal charms for curing hydrophobia and one for exorcising the venom of scorpion sting.—Dr. B. L. **Chaudhuri**: The weighing beam called *Bisá dángá* in Orissa, with short notes on some weights and measures still current among the rural population of that division. The present paper gives a short description of two beams of the "bismer" type from Ganjam, where this kind of weighing beam is still in extensive use, and is known by the name of *Bisá dángá*, a name strangely similar to the Scandinavian. Two other weighing beams of the same type from the collection of the Indian Museum are also described in the paper, and the probable meaning of the name *Bisá* is discussed.—J. **Hornell**: The recent pearl fishery in Palk Bay with biological notes upon pearl oysters. The acquisition, from the Rajah of Ramnad, of his fishing rights on the Indian side of Palk Bay has permitted of the commencement of a systematic survey of the sea bottom of this region. The existence of two beds of pearl oysters was proved, the oysters being confined to an area of a bed of muddy sand between the $5\frac{1}{2}$ and $5\frac{7}{8}$ fathom contours, and associated sedentary species being few in number. A conservative estimate makes the number of oysters on this bed approximately twenty millions. The oysters from the larger—the Tondi—bed were numerically deficient in pearls, but a small number of pearls were exceptionally large and often of fine quality; the oysters from the smaller—the Kanangadu—beds resembled those from Tinnevelly and Ceylon. The author believes that the Palk

Bay is the motherland of the Mannar pearl oysters. In a second chapter the author discusses first of all the limitations of the pearl-oyster habitat in Palk Bay. A second biological note contains the results of the author's observations on the pearl oyster spat, and he distinguishes three stages of development of the pearl oyster larvæ and estimates that oyster larvæ may be subject to current disposal for as long a period as fifteen days. In a third biological note the author details the results of his investigation on the parasites found in the oysters of the Tondi beds.

BOOKS RECEIVED.

Alignment Charts: their Principle and Application to Engineering Formulæ. By E. S. Andrews. Pp. 32. (London: Published for J. Selwyn and Co. by Chapman and Hall, Ltd.) 1*s*. 3*d*. net.

The Health of the Child. By Dr. O. Hildesheim. Pp. xii+111. (London: Methuen and Co., Ltd.) 1*s*. net.

Nature and Science on the Pacific Coast. Pp. xii+302+plates. (San Francisco: Paul Elder and Co.) 1.50 dollars.

The Essentials of Agriculture. By H. J. Waters. Pp. x+455+xxxvi. (Boston and London: Ginn and Co.) 1.25 dollars.

A First Book of School Gardening. By A. Logan. Pp. vi+151. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Exercises in Laboratory Mathematics. By A. W. Lucy. Pp. 245. (Oxford: At the Clarendon Press.) 3*s*. 6*d*.

Arithmetic of Alternating Currents. By E. H. Crapper. Pp. vii+208. (London: Whittaker and Co.) 2*s*. 6*d*. net.

Alternating-Current Work. By W. P. Maycock. Pp. xxiv+415. (London: Whittaker and Co.) 6*s*. net.

Morals in Evolution. By Prof. L. T. Hobhouse. Pp. xvi+648. (London: Chapman and Hall, Ltd.) 10*s*. 6*d*. net.

Masonry. By Prof. M. A. Howe. Pp. ix+160. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

Working Data for Irrigation Engineers. By E. A. Moritz. Pp. xiii+395. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s*. net.

The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes. By Prof. D. Holde. Translated by Dr. E. Mueller. Pp. xv+483. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s*. net.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Pp. xiii+410. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

All About the Zeppelins and other Enemy Aircraft. By F. Walker. Pp. 32. (London: Kegan Paul and Co., Ltd.) 6*d*. net.

Railroad Field Manual for Civil Engineers. By Prof. W. G. Raymond. Pp. vii+386. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

Overcrowding and Defective Housing in the Rural Districts. By Dr. H. B. Bashore. Pp. 92. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 4*s*. 6*d*. net.

The Internal Combustion Engine. By H. E. Wimperis. New edition. Pp. xvi+319. (London: Constable and Co., Ltd.) 6*s*. 6*d*. net.

The Near-Eastern Problem and the Pan-German Peril. By V. Yovanovitch. Pp. 47. (London: Watts and Co.) 6*d*. net.

Russia and Democracy: the German Canker in Russia. By G. de Wesselitsky. Pp. viii+96. (London: W. Heinemann.) 1*s*. net.

Plane Trigonometry. By H. L. Reed. Pp. xiii+290+xvi. (London: G. Bell and Sons, Ltd.) 3*s*. 6*d*.

Elementary Studies in Plant Life. By Prof. F. E. Fritsch and Dr. E. J. Salisbury. Pp. xv+194. (London: G. Bell and Sons, Ltd.) 2*s*.

Statics. By R. C. Fawdry. Part ii. Pp. v+159–305+viii. (London: G. Bell and Sons, Ltd.) 2*s*.

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THURSDAY, JULY 15, 1915.

NEW BOOKS ON BRITISH BOTANY.

(1) *The Potamogetons (Pond Weeds) of the British Isles.* By A. Fryer and A. Bennett. Illustrated by R. Morgan. Pp. x+94+60 plates. (London: L. Reeve and Co., Ltd., 1915.) Price £5 5*s*. net.

(2) *Floral Rambles in Highways and Byways.* By Rev. Prof. G. Henslow. Pp. 294. (London: S.P.C.K., 1915.) Price 6*s*. net.

(3) *A Pocket Synopsis of the Families of British Flowering Plants.* By W. B. Grove. Pp. vi+49. (Manchester: At the University Press; London: Longmans, Green and Co., 1915.) Price 1*s*. net.

(1) STUDENTS of British Botany and workers in general on pond weeds will welcome the appearance, after many days, of the completion of the monograph on British potamogetons which is associated with the name of the late Alfred Fryer. The monograph presents the results of an intimate study in their native habitats and extending over many years, of the species of one of the most critical of genera. In his home at Chatteris, in the fen country, Fryer was especially well situated for observing at first hand a large number of forms of this remarkably variable genus, and the retirement in which he lived, though a matter of regret to his botanical friends, gave the opportunity for close and uninterrupted study. The critical notes which accompany his very full description of the species, varieties, and forms are evidence of his thorough and painstaking methods, and the great value of his work is enhanced by the large series of beautifully prepared specimens numbering many hundreds which he bequeathed to the British Museum, where, in the Department of Botany, they will form a permanent record available for future use.

To the few botanists who were privileged to know Fryer it will be matter for regret that a brief account of his life was not included in the volume which records the results of his botanical work; the two were so intimately connected. At any rate, some explanation of the genesis and course of the work was due. No reference is made to the fact that three parts containing 56 pages of text and 36 plates were published in 1898 (two parts) and 1900, and that a fourth part, edited by Mr. A. H. Evans from Mr. Fryer's MS. appeared, with 13 plates, in 1913. The work was completed by the issue in March, 1915, of a concluding part by Mr. Arthur Bennett, with an introduction to the whole and a key to the species.

It was fortunate that Mr. Bennett, a friend of and co-worker with Fryer, and a botanist whose knowledge of our pond-weeds is unequalled, was able to complete the work. The volume as it stands, though a connected whole, thus represents three portions—an earlier portion, including seventeen of the total forty-two species and hybrids, which had been completed and published by Mr. Fryer before his death; a second portion, the difficult *lucens* group, which Mr. A. H. Evans has been able to edit from Fryer's MS. and published notes; and a third portion dealing with the grass-leaved group for which Mr. Bennett is solely responsible.

The text is well arranged and remarkably clear, though there is some want of uniformity in matters bibliographical. The work of the artist, Robert Morgan, is left to speak for itself. It is no detraction from the value of Fryer's work to emphasise the importance of the coloured plates, the great majority of which were drawn by Morgan from living plants supplied by the author; and there is no doubt that Morgan's untimely death in 1900 was a leading factor in the cessation of publication. The omission from the plates of the name of the species is to be regretted.

Apart from its value as a purely systematic work, the volume is of special interest as indicating methods of study and as throwing light on questions of variation and species-status in aquatic plants.

(2) It is difficult to realise when looking through Prof. George Henslow's latest volume that the author was an active botanist before most modern workers in the science were born. There is a freshness and juvenility about the series of rambles which form the subject of his eminently readable chapters, and we congratulate Prof. Henslow on the mental vigour which he retains with his fourscore years. In a series of fourteen chapters with titles such as "Along a Road's Sides," "By Hedges and Ditches," "Through Marsh-land," "In the Water," and others similar, he has brought together an amount of information about our commoner plants in a manner intelligible to any reader who has a slight knowledge of botany. Some of the more striking features of the plants characteristic of the various habitats are described, and interesting notes on their natural history, such as pollination, methods of climbing, etc., and on their distribution and folklore, are given. As was to be expected, the author seizes every opportunity to emphasise his view of

the origin of plant-form and structure as a direct response to the stimulation of its environment. The book is well illustrated by blocks nearly all of which are old friends (though the source is rarely indicated; many are borrowed from Johns' "Flowers of the Field"). There are also a number of, generally poor, coloured plates.

(3) Mr. Grove's pocket synopsis of the families of British Flowering Plants is a systematic enumeration of the characters of these families arranged under their orders and larger groups, on the lines of the system adopted by Engler in his "Syllabus." It is carefully compiled and "is intended primarily to facilitate the determination of the families of British plants by students." Most students will, however, probably wish to proceed further than the family and will prefer to use handbooks already in existence which enable them to do this.

TEXT-BOOKS OF CHEMISTRY.

(1) *Intermediate Practical Chemistry for University Students.* By F. W. Atack. Pp. viii + 204. (London: Sherratt and Hughes, 1914.) Price 4s. net.

(2) *The Manufacture of Organic Dyestuffs.* By Prof. A. Wahl. Translated by F. W. Atack. Pp. xiv + 338. (London: G. Bell and Sons, Ltd., 1914.) Price 5s. net.

(3) *Outlines of Organic Chemistry.* A book designed especially for the General Student. By Dr. F. J. Moore. 2nd edition. Pp. xi + 325. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 6s. 6d. net.

(4) *Elementary Practical Chemistry for Medical and Other Students.* By J. E. Myers and J. B. Firth. Pp. viii + 194. (London: C. Griffin and Co., Ltd., 1914.) Price 4s. net.

(5) *A Text-book of Inorganic Chemistry.* Vol. i. Part i., An Introduction to Modern Inorganic Chemistry. By Dr. J. N. Friend, H. F. V. Little, and W. E. S. Turner. Part ii., The Inert Gases. By H. V. A. Briscoe. Pp. xv + 385. (London: C. Griffin and Co., Ltd., 1914.) Price 10s. 6d. net.

(1) THIS little volume presents in some respects an original method of treating practical chemistry. After the usual preliminary description of the wash-bottle and its applications, etc., a series of above one hundred little qualitative and quantitative experiments are introduced, the interpretation of which the student is expected to supply. These are excellent so far as they go, but an occasional grouping of the observed phenomena might have been introduced with advantage as a sort of sign-post to the student. The usual tables are, however, postponed until the student is conversant with "identifications" by the dry way. After a very full account of qualitative analysis by the wet way, which includes tests for the rare metals, a section is devoted to preparations of pure substances and to gravimetric and volumetric analysis. The book is, in short, a very useful compendium of practical inorganic chemistry, and for those who intend to become professional chemists it may be unreservedly recommended.

(2) This book on organic dyestuffs is a translation from the French of Prof. A. Wahl, who fills the chair of industrial chemistry in the University of Nancy. We have it on the authority of Dr. Knecht, who has written a short introductory notice, that it supplies a real want, and that it was, in fact, at his suggestion that "this excellent little book" was translated.

It deals essentially with the production of the dyes from the raw material, and includes an account of the distillation of coal tar and the manipulation of the intermediate products. It enters neither into the theory of organic chemistry nor into the application of the dyes to the fibre. The student is therefore recommended to equip himself beforehand with a substantial knowledge of organic chemistry. Moreover, the book does not profess to transform the student into a practical colour-maker, for few details of the actual manufacture or the character of the plant are supplied. We may presume, therefore, that he will receive the necessary practical training concurrently with the study of the text-book if he intends to enter this branch of industry. For we cannot conceive how any student of ordinary intelligence can commit to memory the description of such a variety of compounds, many of which possess highly complex formulæ, without some pegs of practical experimental work to hang his information on.

The publication of this little volume comes at an opportune moment, when it is highly desirable that the interest of young chemists should be stimulated in the direction of colour-making. It is noteworthy that at the end of the volume the list of books of reference which is given includes a substantial number of English and French, in addition to German authors.

(3) Dr. Moore's "Outlines of Organic Chemistry," published originally in 1910, has now reached a second edition. The new edition, whilst retaining the original character and arrangement, represents a thorough revision, and includes the description of a number of new substances of practical interest, namely, citric acid, the fulminates,

and the chemistry of rubber, tannin, and the cyanides. The book is sufficiently well known to need no elaborate description.

(4) The "Elementary Practical Chemistry" by Messrs. Myers and Firth is written mainly for medical students, who, according to the authors, have experienced a long-felt want of this particular kind of aid to practical work. The information, though neither new in substance nor arrangement, is selected in accordance with the syllabuses of most of the medical examining bodies in order, it is presumed, that the overworked medical student may not expend his energies in stepping beyond their well-defined boundaries. This remark is not made in any spirit of cynicism, for it is becoming more and more evident that, with the present overcrowded courses in other branches besides that of medicine, special instruction must be devised for particular classes of students.

We have no hesitation in recommending the book, not only to medical students but to any class of beginners, as a useful introduction to practical chemistry. It is divided into four parts; the first deals with chemical manipulation and a variety of preparations, the second with qualitative, the third with quantitative analysis, and the final chapter is devoted to organic analysis. We would submit two suggestions to the consideration of the authors, though, perhaps, they overstep the syllabus; to combine rough quantitative measurements with such preparations as the reduction of copper sulphate to copper or the preparation of quicklime from marble, to which they readily lend themselves. There seems no reason to wait until part iii. is reached. The second point is to modify part iv. so as to introduce a group of simple organic preparations before entering on the qualitative side of the subject. We confess to having our misgivings as to the value of this section.

Organic chemistry, as represented by organic compounds used in medicine, is not to-day what it was a quarter of a century ago, and the perfunctory testing of a few dozen of the simplest substances selected from the wide range of complex medical preparations now manufactured has neither an educational nor a practical value. It is, of course, not the authors, but the syllabus which is at fault, for the growing importance of organic chemistry for the medical man demands a much more intimate knowledge than most of the syllabuses are devised to meet.

(5) Dr. J. N. Friend, the editor of this new text-book of inorganic chemistry, points out that, whilst physical and analytical chemistry have been comprehensively dealt with in the form of text-books, inorganic chemistry can show no similar publication, and the present projected series of nine volumes is intended to fill the gap. Each volume is written by one or more authors, well known and accredited in the chemical world, so that the new volumes, so far as authorship is concerned, hold out every promise of success. That the series, if efficiently done, will be welcomed by those who can afford to purchase it, almost goes without saying; but it is to be feared that nine volumes at ten shillings and sixpence each will appeal more to public libraries than to private purses.

After reading through several chapters and dipping into others, the impression we have received is entirely favourable. The matter is not only well and thoughtfully arranged and clearly expressed, but (what is less common in the larger text-books containing great masses of condensed information) it is presented in an attractive, literary form. Whilst giving full weight to the many excellent features of the work, it is not, perhaps, irrelevant to inquire for what class of readers it is written. It is obviously not a work of reference, such, for example, as Dammer's "Handbuch." It is too big and costly to serve as a text-book for advanced students, though there is much that they might read with profit. The question, in short, is whether a big and expensive text-book affords the best means of conveying to a large number of readers the latest discoveries in a growing science like chemistry. It generally means the reiteration of a large amount of elementary matter, with an expenditure of space which could be more profitably applied to expanding the subject on its less familiar side.

To take an example from the present volume, a chapter on the classification of the elements leads naturally to the familiar facts of the periodic law, which is discussed at some length. Our interest having been stimulated up to this point, we come upon a paragraph entitled "Modifications of the Periodic System," in which we are informed that there is no space to discuss it, our curiosity having to be appeased with three-quarters of a page of references. The work of the Braggs on molecular structure, which is certainly among the most important contributions to the subject during the present century, is relegated to a footnote with numerous references, and there are many other examples of the same kind. It is as if we had been invited to take a journey into foreign lands, and, having started, had been presented with a Baedeker instead.

We are strongly of opinion that, with a mobile science, the system of cheap monographs, which can without great cost be from time to time re-edited, would serve the more useful purpose of bringing the subject up to date, and of reaching, by reason of their cheapness, a larger number of readers than this more costly form of advanced literature, excellent though it may be. J. B. C.

THE PHYSICAL BASIS OF GEOGRAPHY.

Physical Geography. By P. Lake. Pp. xx + 324. (Cambridge: At the University Press, 1915.) Price 7s. 6d. net.

PHYSICAL geography is already represented by numerous elementary text-books, and by other more ambitious works, most of which deal with particular branches of the subject. Mr. Lake's book occupies an intermediate position, being suitable for the needs of teachers and university students. The result is admirable, and the author is to be congratulated, not only on the accuracy of the subject matter, but also on the lucidity and attractiveness of his treatment.

The book is divided into three sections, dealing in turn with the atmosphere, the oceans, and the lands. The first of these is perhaps the most valuable, or at least calls for most praise, for climate and weather, being still imperfectly understood even by their special students, have afforded many a pitfall for the unwary writers of general text-books. Any attempt at undue simplicity is to be deprecated in the interests of accuracy, and Mr. Lake has steered a happy course between the temptation to describe ideal cases, on the one hand, and the danger of citing confusing masses of actual meteorological data, on the other. The author points out the desirability of planning a teaching-course so that the study of the atmosphere occupies the winter session, leaving the land to the summer months when field excursions can be taken.

In the section dealing with the oceans, the chapter on waves and tides should be particularly useful to the student, for these subjects are effectively handled with enviable ease. A chapter is devoted to coral reefs and islands, and the views of Darwin and Murray are presented, but no mention is made of Daly's recent contribution to the controversy, in which he correlates the formation of atolls and barrier reefs with the lowering of sea-level that accompanied the Pleistocene glaciation, and its subsequent rise as the ice melted (*Amer. Journ. Sci.*, 1910, p. 297). The chapters which treat of the land are uniformly good. They constitute a delightful exposition of dynamical geology, and one feels that they are all too short. The temptation to have written more must have been strong, for rivers, and glaciers, and volcanoes have a way of leading one further and further afield in the realm of earth-lore. Mr. Lake has written just enough in this, and in the other sections, to fire the student with interest, and no text-book can hope to achieve more.

The book is well illustrated with twenty plates, 162 figures in the text, and a series of maps illustrating isobars, isotherms and rainfall, those of the latter being coloured. Altogether it is a very refreshing text-book, and it has the advantage of satisfying a real need in the teaching of physical geography. ARTHUR HOLMES.

OUR BOOKSHELF.

Smithsonian Physical Tables. Sixth revised edition. Prepared by F. E. Fowle. Pp. xxxvi + 355. (Washington: Smithsonian Institution, 1914.)

THESE physical tables, originally compiled by Prof. Thomas Gray in 1896, have been revised by Mr. F. E. Fowle, of the Smithsonian Astrophysical Observatory. The number of tables has been increased from 335 in the fifth to more than 400 in the sixth edition. The new matter includes a new set of wire tables from advance sheets supplied by the Bureau of Standards, mathematical tables compiled by Mr. C. E. Van Orstrand, and data relating to Röntgen rays and radio-activity. Thus we find a table giving Moseley's atomic numbers and the wave-lengths of lines in the X-ray spectra of the elements. We miss, however, determinations of the ratio of the charge to the mass of an electron. The mass of an electron is very nearly 9×10^{-28} grams, not 6×10^{-28} grams (Table 406). Sadler, on p. 336, no doubt through association with Barkla, becomes Sadla! It would be useful to have the value of the electro-chemical equivalent given for some elements other than silver. These, however, are minor blemishes, and actual use of the tables during two months has proved their great value. It is not too much praise to say that a copy should be in every scientific library and advanced physical laboratory. It may be of service to state that the volume may be obtained in Great Britain, where it should be more widely known, through Messrs. Wm. Wesley and Son, Essex Street, Strand, W.C., at 8s. 6d. net.

The Design of Steam Boilers and Pressure Vessels. By Prof. G. B. Haven and Prof. G. W. Swett. Pp. vii + 416. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 12s. 6d. net.

THIS book is a comprehensive treatise on the design of steam boilers and other vessels subjected to internal fluid pressure. The subject naturally divides itself into questions of strength, of providing dimensions suitable for the thermal operations involved, and the production of working drawings embodying the results of the calculations. The authors have endeavoured to harmonise the rational methods of both theory and practice;

wherever possible results have been found by rational rather than empirical methods. The design of a steam boiler, so far as strength is concerned, is a matter in which the designer has but small latitude. In this country he has generally to make the results of his calculations conform to the rules of the Board of Trade, or of Lloyd's Committee, or of both. Hence the book will be of greater service to the student than to the practical designer, although there is much in it which will appeal to the latter also.

Naturally much reference has been made to the Massachusetts Boiler Rules, which have been used as a model by many States and adopted bodily by others. It is of interest to note that, with certain exemptions, these rules provide that all boilers shall be inspected when installed and annually thereafter by the inspection department of the district police, under supervision of the chief inspector of boilers. In this country the periodic inspection of land boilers is left to the owner, who generally delegates the matter to his insurance company. If the boiler is not insured, periodic and competent inspection may, or may not, be carried out, and depends entirely on the owner's workmen or engineer.

The book is well illustrated and contains several fully worked out designs. These, and the methods of calculation, are of considerable interest and will be of service to engineers in this country who wish to acquaint themselves with up-to-date American practice in boiler design.

Mechanical Drawing, with Special Reference to the Needs of Mining Students. By J. Husband. Pp. 79. (London: Edward Arnold, 1915.) Price 3s. net.

Readers of this excellent text-book will have a feeling of satisfaction that a piece of good work, evidently much needed, has been conceived and carried out in a thoroughly efficient manner. Teachers and students connected with mining and colliery engineering are much indebted to the author for putting at their disposal, in a convenient form, material which will specially appeal to them and will prove most helpful in the drawing classes and an incentive to study.

The course is progressive, beginning with some excellent advice on the selection and manipulation of drawing instruments. The well-executed drawings are fully and clearly detailed and dimensioned, and the descriptions are always suggestive in pointing out the leading features of a design, and are models of conciseness and lucidity.

The examples selected are welcome on account of their freshness, importance, and suitability. In order to give an idea of the scope of the work we may instance the plates on bolt and rivet fastenings; built-up work, such as stanchions, girders and pump quadrants; pedestals, shafts and axles for wagons and winding engines; mine cages and colliery tubs; haulage clips and safety hooks; mine pumps; pneumatic hammer drills.

We strongly recommend teachers of elementary machine drawing to consult this most useful manual.

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 Use of Cotton for the Production of Explosives.

While in no way attempting to dispute the authority of the writer of the article on gun-cotton in Nature of July 1, I should like to take the opportunity of expressing my surprise at the conclusions there reached. On general grounds one would anticipate that plant-products, such as cellulose and alcohols, could be prepared in any country, so long as plants grew; they stand in sharp distinction from metals and petrol, which are not of universal occurrence.

It scarcely seems likely that the suitability of cotton as the cellulose basis for certain explosives can be due entirely to chemical peculiarities, for although cotton is a typical cellulose it contains many impurities—mineral salts, dead protoplasm, cuticle, waxes. These cannot all be entirely removed in course of manufacture, and it is presumably their presence which necessitates the very careful blending employed in preparing cotton for nitration. It seems more likely that the matter is one of physical properties, the thin-walled, hollow, pitted cylinders of the cotton hairs offering a large surface to reagents.

But if this were the prime advantage of cotton, it is not one which need inhibit the use of other forms of cellulose for the making of "gun-cotton." Even the best cotton is by no means uniform from hair to hair, and the waste cotton used for nitration is still more irregular; consequently, it seems likely that an artificial cellulose might be made even more uniform than cotton. It would scarcely be possible to make such a product with the same ratio of surface to mass as is found in natural cotton hairs, but this ratio could at least be made constant, *e.g.* by dissolving the cellulose and squirting thin threads of it, in the form of "artificial silk." The trade in these artificial silks is mainly Continental, and has been developing rapidly during the last ten years, so that there should be no lack of knowledge of the process in Germany.

Undoubtedly "gun-cotton" made in this way would be quite different from true gun-cotton. All values would have to be re-computed; the trajectory, with the sighting and timing, would be altered, and a great deal of extra work would be thrown on all concerned, but with all submission to the chemists, to whose domain this matter belongs, I venture to think that it may be *possible* to turn out perfectly uniform "gun-cotton" with cellulose derived from plants other than cotton. The question of cost is immaterial in the circumstances, and although it cannot be doubted that the cutting off of Germany's cotton supplies would hinder the German guns, yet it seems likely that a fairly effective substitute might be devised by the nation of technologists.

Carlyle may be quoted in this connection. "Interrupted Commerce and the British Navy shut us out from saltpetre; and without saltpetre there is no gunpowder. Republican Science again sits meditative. . . . What of saltpetre is essential the Republic shall not want." W. Lawrence Balls.

Little Shelford, Cambridge, July 7.

I have read not only with interest, but also, I hope, with some instruction to myself, the admirable letter from Mr. Balls which you have been kind enough to let me see. I am entirely in accord with him in his view that as long as plants grow so long will cellulose be formed, and with this as a basis nitro-cotton can certainly be prepared. I do not wish to convey the idea that the reason why cotton waste is chosen for making nitro-cotton is its chemical idiosyncrasies, but rather that it is the most abundant and fairly uniform stuff which is available for practical use. Mr. Balls is quite right in thinking that the physical structure of cotton fibre has much to do with the applicability of cotton for making propulsive explosives, but this cuts both ways, because even cotton is troublesome in that those fibres tend to retain acid, which has to be removed by regulated boiling and washing. Hence the suggestion that an artificial "cotton" might be used is well worth considering—dissolved and squirted cellulose being necessarily fairly uniform—and I agree with Mr. Balls that it would not only be possible but also tolerably easy to turn out perfectly uniform gun-cotton made this way.

Nobody has denied from the beginning of the discussion which has taken place in the Press on the subject of cotton for explosives, that nitro-cotton can be prepared from any source of nature which can provide us with cellulose, but the issue is really rather different. It is impracticable for a factory accustomed to using a particular raw material so to alter its operations as to use another raw material without great delay, expense, and in this case much danger. The other difficulty has been mentioned by Mr. Balls, and is that of the artillerist who, given even a better nitro-cotton than that to which he is accustomed, would have to learn his art all over again, and meanwhile it is of more advantage to his country that he should be sighting his gun in the manner to which he is accustomed. To use a homely expression, it is generally a mistake to swap horses in crossing a stream.

THE WRITER OF THE ARTICLE.

The Great Aurora of June 16, 1915.

THERE have been comparatively few auroras here of late years. In that time we have passed through the aurora minimum. Lately, however, there have been distinct indications of an awakened activity in the frequent appearance of auroral glows and arches. But these were generally feeble, and at best showed very little in the way of streamers or other signs of activity.

The night of June 16 was very clear throughout, and gave us one of the finest displays of the aurora that I have seen. Before the moon set there was a very strong, low-lying arch in the north. This was not active, but its intensity seemed to suggest the possibilities of a great display.

At 15h. 30m. G.M.T. the arch was very low and flat, and extended a great distance towards the east and west. There were no streamers.

At 16h. 10m. there were no streamers, but there was considerable action underneath the arch in the way of brightening masses. At 16h. 50m. the arch was double in its eastern part, the upper portion extending to the lower part of Cassiopeia.

By 17h. 10m. the aurora was very brilliant and active, the arch having risen and spread all over the north, nearly as high as the pole. The lower part of the arch was broken with bright moving forms. A few minutes later the arch had risen above the pole, while below it there was very little auroral light except a few streamers. By 17h. 30m. the aurora had quietened down, and the great spasm, seemingly caused by the rising of the arch, had subsided, with the exception of some great bright masses in the north-west, where the remnants of the arch had drifted.

By 18h. 13m. a low, strong arch, slightly active, had again formed in the north. The new arch soon rose and also became double.

By 19h. 43m. the arch was breaking up, and very long streamers were ascending everywhere. By 19h. 52m. quick waves of light were ascending towards the zenith, succeeding each other with remarkable rapidity. These waves continued without intermission until dawn blotted them out about 21h. 5m.

After about 19h. 40m. the display rapidly increased in magnitude, and attained its maximum splendour at about 20h. 10m. or 15m., when it became too bewildering to describe. The whole heavens seemed alive with flickering and dancing light. The rapid waves of light and the streamers were ascending in all directions, even from the south, to a focus that appeared to be on or near the meridian and about 20° south of the zenith. (Its declination was roughly +23°.) This focal spot was occupied by some of the irregular luminous masses which were momentarily brightly illuminated by these waves. The streamers were no longer slender rays; they were now broad sheets of light along which the ascending waves raced with intense rapidity, giving them the appearance of flames rushing up from the horizon to and beyond the zenith. These quick light waves momentarily and brightly illuminated every object over which they passed. The sky was full of wisps and curved streaks of luminous matter over which the light waves took a sensible moment to pass. This produced a remarkable effect. As the light ran from end to end of them the rapid brightening seemed to give life and action to these streaks and produced in them a writhing and darting motion which they did not possess, for their real motion and change of form was quite sluggish. As late as 21h. 25m., when the sky was bright with dawn, some of the great bright masses were still visible in the north-west.

There was but little colour in the display at any time, though some of the streamers and masses assumed a slight pinkish tinge at about 19 hours. Efforts were made several times to form curtains at the bases of masses of streamers, but no regular curtains were actually formed.

Throughout the night I was photographing with the Bruce telescope. As frequently as possible notes were made of the progress of the aurora. At 20h. 0m. the sky was so brilliantly lighted that I was forced to close the exposure. The resulting negatives were badly fogged with the auroral light, which seemed to be more actinic than moonlight.

The present aurora was much like that of 1903, October 30 (see *Astrophysical Journal*, vol. xxxi., p. 212), in its phenomena and its effects on the telegraph systems, but exceeded it in some respects.

From the newspaper accounts we learn that the aurora was visible over the greater part of the United States and Canada. It was strong even in California.

A despatch to the *Los Angeles Tribune* of June 18, from Spokane (Washington), dated June 17, says:—

"Electrical currents caused by the aurora borealis almost stopped telegraph service in northern Idaho, Montana, and the Dakotas between midnight and 1 o'clock this morning. Up to 9 o'clock this morning the Western Union Telegraph Company reported interrupted service, but not to such a great extent as in the hour following midnight."

In the *Chicago Tribune* of June 18 a despatch from New York, dated June 17, says:—

"Following the spectacular appearance last night of the aurora borealis, which lighted the entire north-west, came reports to-day of crippled telegraph and cable service. The effect of the electricity from the northern lights was felt on wires in a zone stretching across the continent, and as far south as Pittsburgh.

"Across northern Idaho, Montana, and the Dakotas service virtually was suspended. Like unsatisfactory conditions prevailed on all the northern transcontinental lines.

"For several hours during the early morning cable communication *via* the Newfoundland cables of the Western Union was all but paralysed."

During the progress of the aurora, Mr. Frank Sullivan and Mr. E. P. Hubble, of this observatory, tried the wirless receiver here, with which time-signals are received from Arlington, Virginia, Mr. Sullivan at 14h. 45m., when the arch was strong but not active, and Mr. Hubble at 20h. 0m., when the greatest display occurred. They found in both cases that the static conditions were normal. Mr. Sullivan reports that it was unusually quiet. E. E. BARNARD.

Yerkes Observatory, Williams Bay, Wisconsin, June 25.

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

A CORRECTION is necessary for the value of 1′ of arc displacement for the H.F., given in my letter published in NATURE of June 24. It should read, line 18 ($1' = 4{\cdot}0 \times 10^{-5}$ C.G.S. units). There is also an ambiguity in the preceding line, in the use of the word displacement. The extreme values of the greatest oscillation in the H.F. about 4.15 p.m. amounted to 100′, as stated, but the maximum displacement was 76′, the value of the base line being 24′.

In his very interesting letter on this subject (NATURE, July 1), Dr. Chree mentions several dates on which sudden movements of the magnets occurred, which are presumably of cosmic origin. It may also be of interest to compare the state of the solar surface on these dates with these sudden movements. The first occurred at 1 p.m. on June 16. On this date the two sympathetic groups of spots, which I have associated with the magnetic storm of June 17, evinced considerable disturbance, the faculæ in the neighbourhood of these two groups, as also bright faculæ conjoined with two other groups nearer the E. limb, showing a decided drift towards the south. On June 18, as already described in my last letter, the whole of the region between these two groups was violently disturbed, and the faculæ, which must have been very bright to be visible in the middle regions of the sun, showed the same southerly drift. As this was visually the most disturbed region of the sun, and, moreover, it was near the heliographic position of the earth, it seemed most likely that this region was the one connected with the magnetic storm, if any such direct connection exists.

On June 14 a bright compact patch of faculæ appeared in the N.E. quadrant on the sun's limb, in which were a few small dots. This new disturbance continued to grow, until on June 21 it had developed into a fine group of large spots near the central meridian. Its mean approximate position was $+17°$ latitude, and 356° longitude. This region was also much disturbed on June 19. Dr. Chree directs attention to the considerable magnetic disturbance which commenced at 3.10 p.m. on June 21 with a sudden movement of the H.F. magnet. Dr. Chree also mentions another sudden commencement on June 7 "of considerable size at a time when Father Cortie tells us the sun was almost free from spots." On that date there was only one group of very small spots at mean latitude $+21°$ and longitude 198°, in a ring of faculæ. But I find on consulting our solar drawings that M. Henroteau, the observer, has made the following note on the drawing of June 8, with regard to this group of very small spots: "The region of the spots seems very disturbed."

Finally, that quiet magnetic conditions show the twenty-seven day period is not inconsistent with, but would naturally follow from, successive synodic presentment earthwards of an undisturbed hemisphere of the sun. A. L. CORTIE.

Stonyhurst College Observatory, July 4.

Use of Tyrosine in Promoting Organic Growth.

I DESIRE to direct the attention of readers of NATURE to the influence of tyrosine in promoting the growth and multiplication of any organisms that may be found in tubes five to ten months after they have been hermetically sealed and sterilised, as described in "The Origin of Life," second edition, 1913, and NATURE of January 22, 1914.

The June number of the Proceedings of the Royal Society of Medicine contains an illustrated communication dealing with the effects of this powerful auxetic when used in the form of a 0·05 per cent. solution. Its influence was tested on a large number of tubes ripe for examination, containing five different kinds of experimental solutions (the constitution of which is given) by adding, with all necessary precautions, about twenty drops of the tyrosine solution to each tube when it was opened. The tubes were then reclosed and replaced in the incubator for three to four weeks. When the contents of these tubes were reexamined after such an interval a very considerable growth and multiplication of unmistakable organisms were found to have taken place, thus tending to disprove the two principal doubts that had been urged against the original experiments by showing (1) that what were found were not mere pseudo-organisms; or (2) organisms which had pre-existed in the solutions, and had been killed by the sterilising process. Photomicrographs of the organisms taken from the tubes before, as well as after, the addition of the tyrosine show its great influence in favouring the multiplication of bacteria, torulæ, and moulds.

I have quite lately heard from the brothers Mary (Institut de Biophysique, Paris) that they have been similarly successful in obtaining from some of their tubes, after the addition of tyrosine, plenty of budding torulæ, as well as delicate spore-bearing moulds, and that they are about to publish an account of their investigation.

The last number of the Proceedings of the Royal Society (B. 609) contains an interesting paper by Prof. Benjamin Moore and W. G. Evans, in which they describe and figure some simple pseudo-organisms, of a kind with which I am quite familiar, obtained from a limited number of tubes containing solutions apparently similar to some of those which I have used. I have prepared and examined more than a thousand of these tubes, and among them have found many barren series. A comparison of their illustrations with mine will show that they have hitherto met with totally different objects. It is true, however, that some of their finds, under the low magnification which they employ, have a superficial resemblance to matted or twisted hyphæ of moulds (see especially Figs. 1, 7, and 11).

The simplest solution from which I have obtained different kinds of moulds, and which I can recommend to others, is one made from 10 per cent. solutions of iron sulphate and potassium ferrocyanide, in which one drop of the former and two of the latter are added to each 30 c.c. of distilled water. The iron stock solution changes colour somewhat after a time, owing to oxidation of the ferrous salt, as Sir Wm. Ramsay tells me, and the moulds found in solutions prepared from fresh stock fluids and from others one or two months old have been of a different kind. The remarkable mould of Cladosporium type referred to in a note to my paper was found in each of a series of tubes the solutions of which had been prepared from stock fluids one month old. An examination of the stock fluids themselves, even after three months, does not reveal moulds of any kind.

H. Charlton Bastian.

Fairfield, Chesham Bois, Bucks, July 9.

Napoleon and the University of Pavia.

The following allusion to Napoleon having spared the University of Pavia in 1804 on account of the memory of the illustrious man of science, Spallanzani, who had been a professor there, is so interesting at the present time that I venture to bring it under the notice of readers of Nature.

The passage is from Baron's "Life of Dr. Edward Jenner" (vol. ii., p. 35), which was published in 1838:—"He who flushed with victory and at the head of the revolutionary army of France had spared the University of Pavia out of respect to the genius of Spallanzani when the city itself was given up to plunder, proved that the claims of science were not forgotten amid the astonishing events which carried him forward to the highest pinnacle of ambition. His animosity to England had been shown in that vehement and decided manner which marked all his actions; yet there was one chord of sympathy unbroken which, when duly touched, showed that his intoxicating success had not raised his proud spirit beyond some of the calls of justice and humanity, and that he could still be moved by the peaceful arguments of truth and science."

Napoleon's conduct in regard to the ancient University of Pavia is in striking contrast to that of the Kaiser in regard to the University of Louvain. The Germans, in their own opinion, are pre-eminent in the subject of the history of medicine, and yet it has been reserved for Germans to destroy the University of van Helmont, the father of chemistry, of Vesalius, the father of anatomy, of Schwann, the originator of the cell-theory. Further comment seems unnecessary.

D. Fraser Harris.

Dalhousie University, Halifax, N.S., June 19.

A New Tsetse-Fly from Zululand.

The Durban Museum has lately received from Mr. R. A. L. Brandon, the magistrate of Ubombo, Zululand, a tsetse-fly captured by him in the court-house at Ubombo, towards the end of March, which is very distinct from the ordinary Zululand species, *Glossina pallidipes*, Austen, and apparently belongs to an hitherto unknown form.

It is a member of the *palpalis* group, and seems most nearly related to *G. tachnoides*, Westw., but the markings on the abdomen are not so strong or so sharply defined, and the dorsum of the thorax is buff. It is a female, and measures 8 mm. in length, exclusive of proboscis. In honour of the captor it may be known as *Glossina brandoni*.

It is my intention to give a detailed description in the next number of the "Annals of the Durban Museum."

E. C. Chubb. (Curator).

Durban Museum, Natal, June 16.

MUNITION METALS.

In this article an attempt is made to compare briefly the resources of the Allies and the enemy countries in respect of metals which are regarded as essential for War purposes.

First in order of importance comes iron, the basis of the modern gun, armour-plate, armour-piercing projectile, shrapnel shell, high-explosive shell, and all the varieties of steel which find application in one way or another. Both sides have a sufficiency of iron ore and the accessories required for smelting, although the deposits in the enemy countries are inferior in quality to those possessed by the Allies. An illustration of this is furnished by a comparison of the amounts of acid and basic steel produced in Germany and Great Britain in 1913—the last year for which the complete figures are available. Germany's total steel production for that year was just under 19,000,000 tons, of which 96 per cent. was made in basic-lined furnaces; Great Britain's output was 7,663,000 tons, of which only 36 per cent. was made by the basic process. Both countries, however, imported considerable quantities of Swedish pig-iron, which is used for the manufacture of steels of the highest class, *e.g.*, tool steels, and Great Britain also imported substantial amounts of Spanish hematite ore, which was smelted with the clay ironstone ores of the Cleveland district, which are low in iron, and contain, for the most part, more phosphorus than is compatible with the transformation of the resulting pig-iron into steel by any acid process.

The production of open-hearth steel from pig-iron—and such steel provides the casing of the high-explosive shell and the shrapnel shell—demands, however, a second and very important metal, namely, manganese, which in the form of ferro-manganese or silico-spiegel is used not only to de-oxidise the fluid steel, but to leave from 0·5 to 1·0 per cent. manganese in the finished product. The chief producers of marketable manganese ore in order of importance are Russia, India, and the United States of America, which in 1913 furnished about 93 per cent. of the total quantity mined. The raw material is pyrolusite, a "straight" manganese ore corresponding when pure to MnO_2. The main supplies of pure ores, therefore, are in the Allied or neutral countries. In 1913 Germany imported about 670,000 tons, chiefly from Russia. The figures of her domestic production in 1913 are not available, but in 1912 her output was 90,980 tons, while that of Austria-Hungary was 16,540 tons in 1913.

In spite of these figures there is no sufficient reason for concluding that the enemy countries will be greatly hampered even if all external sources of supply are shut off, as they probably are. Confining our attention to Germany, the predominant partner, it must be pointed out in the first place that 4,300,000 tons of her steel production in 1913 were exported, and that except in so far as Austria-Hungary and Turkey are concerned this excess would be available for her own munition needs if she could obtain sufficient manganese. In the second place, the last-named metal is relatively widespread and occurs in many minerals. It is only the limited demand and the abundant supply of high-grade ores to draw upon which have confined marketable ores to such products. The enemy countries will in all probability be able to supply their needs by mining lower-grade ores within their own territories, and their metallurgists will no doubt have been able to make the requisite changes in the technology of steel manufacture to meet the altered conditions—quite apart from any stores of pure ore that may have been accumulated before the outbreak of war, and apart from any substitutes that may have been discovered.

The case of nickel, however, is very different. It is an indispensable constituent of gun and armour-plate steel, and of the modern bullet and armour-piercing projectile. In all these instances its action is specific, and it is doubtful whether any satisfactory substitute is known. It is therefore a munition metal of the highest importance. The world's production of nickel in 1912 was about 26,500 metric tons (a metric ton equals 2204 lbs.). Of this, Canadian mines and smelters produced 85 per cent. in the form of a copper nickel matte (sulphide), 89 per cent. of which was refined in the United States and the remainder at Clydach in South Wales, with the production of the pure metals. New Caledonia supplied almost all the remaining ore required, this being shipped to Europe and smelted there. Judged by Canadian standards the Norwegian production of nickel was very small, the output in 1912 being only about 400 tons.

The position, therefore, is that fully 98·5 per cent. of the world's output of nickel ore was being produced in the Allied countries before the war broke out, and that the remainder was furnished by a neutral country. So far as Canada is concerned the situation was dominated by two companies, the International Nickel Co. and the Mond Nickel Co., while the production of nickel ore in New Caledonia was monopolised by two large French companies. The only nickel ores situated in the enemy countries are kupfernickel (NiAs), cloanthite ($NiAs_2$), and nickel glance ($NiS_2 + NiAs_2$). Each of them can be worked for the production of nickel, but how inadequate a source of this metal they were may be judged from the imports of ore and metal into Germany in 1913. In the first six months she imported 6643 metric tons of ore and 3416 metric tons of metal. (It is to be noted, however, that her exports of the same metal were 2409 tons in the same year.) The Norwegian nickel production may still be available for Germany, but this is nothing like enough for her requirements, and apart from pre-war stocks she will have to fall back on the above-mentioned native ores to furnish the requisite quantity of this metal.

Scarcely less important than nickel is the metal chromium, which, though it finds no application in the pure state, is an essential constituent of armour-plate, armour-piercing projectiles, and high-speed tool steels. Rhodesia and New Caledonia furnish between them the bulk of the principal chromium ore, chromite (an iron chromium oxide). Russia produces substantial amounts, while Greece and Asia Minor used to do so, though their output has diminished in recent years. It is more than likely that the requirements of the enemy countries are resulting in an increased output from the last-named countries, and it will be observed that even if Greece joins the Allies the Asia Minor supplies, which are sufficient, will still be open to the German and Austrian armament firms. Chromite is worked up into an alloy of iron and chromium (with or without carbon) known as ferro-chrome, and applied in this form to the production of the particular steel required.

All shells, whether shrapnel, high-explosive, or armour-piercing, are fitted with a copper band which serves a double purpose. It prevents contact between the shell and the gun-barrel, and, owing to its great ease of deformation under stress, accommodates itself to the very rapidly altering stresses set up in the tube after firing, making good contact with the rifling of the barrel, and thus preventing the rush of gas out of it in advance of the projectile. Before the war it was customary to use not pure copper, but an alloy containing a little zinc, as the material of the band, not because the zinc improved the properties of the copper, but because it was a cheaper metal, and a certain proportion of it could be used with only a slight sacrifice of ductility. Now that zinc has become much more expensive than copper there is no object in doing this. Copper is also the main constituent of cartridge brass and shell fuses, Admiralty gun metals, and high-tension hydraulic bronzes, so that from the point of view of both branches of the service it is a most important munition metal.

Of the normal annual world's output of copper —about one million tons—the United States of America produced 55 per cent. in 1913. They are by far the greatest producers of this metal. Next came Japan with 7·3 per cent., followed closely by Spain and Portugal, Mexico, Australasia, Russia, and Chile, each of which supplied between 5 and 4 per cent. Of the Allies Italy furnished 0·16 per cent., Great Britain 0·03 per cent., while France was a non-producer. Of the enemy countries Germany's output was 2·5 per cent., and that of Austria-Hungary 0·4 per cent. None of the belligerent countries except Japan supplied its needs from internal sources in 1913; all of them except Japan imported copper from the United States of America; in that year Germany took 137,000, France 71,400, Italy 18,500, Austria-Hungary about 17,000, and Great Britain 15,000 tons.

The Allies are able to take delivery of such copper as they need, thanks in the main to the British Navy, whereas the enemy countries have found it increasingly difficult to import this metal. The position probably is that they have succeeded in obtaining through neutral shipping and neutral countries more than is generally suspected, but nothing like enough for their war needs, more particularly since Italy joined the Allied countries. In 1913 it is estimated that Germany's consumption was 265,000, and Austria-Hungary's 50,000 tons; their united production was 29,400 tons. There is no means of estimating the War demand for this metal in these countries, to which, of course, Turkey must be added. It is quite certain, however, that its use is being rigorously restricted to purposes for which there is no substitute, and it is extremely probable that large stores were accumulated before the war. The very high price that Germany has recently been willing to pay for copper shows nevertheless that her reserves have been considerably depleted. Two things may be stated with confidence. The first is that all her copper mines, mills, and smelters are being worked to their utmost co-ordinated capacity, the second that her technical metallurgists will have endeavoured to find a substitute for copper shell bands.

Aerial warfare has enthroned aluminium as *par excellence the* munition metal for this purpose, but its war usefulness is by no means confined to the construction of aircraft. One of the greatest metallurgical achievements of the last century was the adding of aluminium to the metals of everyday life. Thirty years ago the world's annual production was 5500 lb.; in 1913 it was estimated to be 173,175,000 lb. In this time it has risen from a rare metal to a yearly tonnage exceeded only by iron, lead, copper, zinc, and tin. To quote Prof. J. W. Richards ("Mineral Industry," 1913, p. 14):—"It can confidently be anticipated that by the middle of this century it will rank next to, or even ahead of, copper. It is already cheaper than tin, pound for pound, and cheaper than copper per unit of bulk or per unit of electrical conducting power, while the range of its applications and usefulness is extending more rapidly than that of lead or zinc."

One of the less well known uses of aluminium is as a constituent of the bursting charge for shells. "Ammonal" is an explosive the constituents of which are ammonium nitrate and finely divided aluminium. It is not a propellent explosive, such as cordite or other of the smokeless powders; its disruptive effect is too great, and its explosion too sudden. But this very fact renders it suitable as a bursting charge for shells, and Austria-Hungary is using it for filling the shells for the howitzer batteries. The United States and Canada produced nearly half the world's output of aluminium in 1913, the remainder being furnished in almost equal amounts by France, Great Britain, and Switzerland, leaving out of account a tonnage of 800 produced in Italy. So far as the Allies are concerned, therefore, they are in a much better position than the enemy countries with regard to the supply of this metal. Moreover, France contains the most suitable European deposits of the raw material of manufacture, viz., bauxite. The Swiss production is available for the enemy countries, and it is known that Germany has since the war become a producer of the metal.

Next there is zinc, the metal of which the selling price has appreciated to five times its pre-war figure. Originally only two-fifths the price of copper, it is now decidedly above it, in spite of a marked appreciation in the price of copper itself. The most important munition uses of zinc are as a constituent of cartridge brass and shell fuses, and as a covering for iron barbed-wire fencing. In 1913 the principal producers of the metal were the United States, Germany and Belgium; whereas, however, the first-named smelted domestic ores, the two latter relied mainly on zinc concentrates imported from the Broken Hill mines in New South Wales, where, owing mainly to the high price of labour, it does not pay to smelt the ore locally, or even in the country. France, Spain and Great Britain also produce substantial amounts, though not enough for their own needs. Although the importation of Australian ore into the enemy countries is now stopped, they have considerable supplies of local ore both in Silesia, Hungary, Carinthia, and Tyrol. Unfortunately for Great Britain her zinc-smelting furnaces are not well adapted for dealing with Broken Hill concentrates, and there are upwards of 80,000 tons seized in enemy shipping which are lying idle in our yards in this country. She is in the unsatisfactory position of having to draw upon the United States for the bulk of her supplies. The shortage of domestic zinc is bound to continue unless works are built and operated which are capable of dealing with the zinc concentrates from Broken Hill. It is therefore of national importance so long as the war lasts that the use of zinc, whether as such or for alloys, should be restricted to purposes for which this metal is absolutely necessary.

Lead calls for only brief mention. Germany is a very large producer, and her output with that of Austria is sufficient for the requirements of the enemy countries. Australia is the largest producer among the Allies, who, however, do not furnish enough for their needs, and draw upon the United States, Spain, and Mexico. The shrapnel bullet is a lead-antimony alloy, the antimony producing the requisite hardening and embrittling effect. In spite of the fact that the shrapnel shell is much less suitable than the high-explosive shell for the offensive land operations of the present war, the price of antimony has appreciated almost as much as that of zinc. The normal annual world's production is less than 20,000 tons, of which China furnishes two-thirds and France the bulk of the remainder. Before the war Hungary was producing about 800 tons per annum, but doubtless this amount could be substantially increased.

Tin as a constituent of tin-plate, the various anti-friction metals, solders, and Admiralty gun-metals, is a munition metal of no small importance, the world's normal annual output being about 120,000 tons. Of this the Federated Malay States produce about half from native ore, in addition to exporting ore which is smelted in various European countries; England comes next as a producer of the metal, although 75 per cent. of her output is derived from imported ores; then follow Banca, Germany, Australia, Billiton, and China in the order mentioned. The enemy countries have hitherto relied on imported ores for raw material, their own deposits being very inadequate.

To sum up, the position may be stated broadly as follows:—Of the ten munition metals, the chief sources of production and uses of which have been passed in review, the enemy countries can certainly produce five without having recourse to imports, viz., iron (the basis of the various steels used for war purposes), manganese, chromium, zinc, and lead; on the other hand, it is doubtful whether they can produce sufficient nickel, copper, aluminium, tin, and antimony from domestic ores. In view of the fact, however, that they prepared for this war with extreme care and foresight, it may safely be concluded that large stocks, either of ores or the corresponding metals, or both, will have been accumulated in those countries. However confident the Higher German Command may ostensibly have been of a rapid victory, they will quite certainly have laid their plans to wage a prolonged war if it should prove to be necessary, and such plans will have included the accumulation of munition ores and metals of which their countries produced an insufficient amount. There is accordingly no adequate reason for concluding that the enemy countries are likely—in spite of the prodigious scale upon which the war is being conducted—to run short of metals which are *essential* for war purposes for some time to come. Moreover, it may safely be concluded that their technical metallurgists will have been mobilised in the direction of discovering substitutes for any of the above metals of which a shortage is liable to occur in a long war.

The Allies for their part can produce from their own resources all the iron, manganese, nickel, chromium, tin, and most of the aluminium they require; their command of the seas enables them to obtain, principally from the United States, their deficiencies in aluminium, copper, and lead; China furnishes the requisite antimony. Zinc is the only important munition metal of which there is a shortage, in spite of the great speed with which the American furnaces are being operated. Wherever it is possible to substitute zinc by another metal it is of national importance that it should be done.

It is satisfactory to note that on July 7 Mr. Lloyd George, in answer to a question in the House of Commons, stated that "the necessary steps have been taken to stop the export of lead, spelter (zinc), antimony, and nickel, and other metals necessary for the manufacture of munitions of war. The four metals named cannot be exported except to places in the British Empire."

H. C. H. CARPENTER.

THE PRODUCTS OF COAL DISTILLATION.

IN a paper before a conference recently held at Cardiff on the extension of British trade, Mr. W. J. A. Butterfield dealt with the many important aspects of this question, which has become of vital national importance to us now that supplies from Germany are cut off. We probably scarcely yet realise how dependent we have been on Germany for many raw and finished products; indeed with many coal tar derivatives it has amounted to a German monopoly.

The output of coal in the United Kingdom in 1913 was 287,430,473 tons; in Germany 188,485,000 tons, but in addition to the ordinary coal 86,093,000 tons of brown coal or lignite were raised. England retained 189,092,369 tons for home consumption in 1913; Germany retained about 155,503,000 tons and 93,455,000 tons of brown coal, part of which was imported. These figures show a mean consumption of coal of 4·108 tons per head in the United Kingdom and 3·68 tons of coal and brown coal in Germany. Broadly speaking, the coal consumption is a measure of the industrial activity of the two countries, and on this basis it is gratifying to note the greater consumption in England.

In order to arrive at some idea of the products available from distillation, the amounts of coal carbonised for gas and coke making, and the quantities treated in recovery plant in the latter case, must be considered. It is estimated that, in 1913, 37,483,944 tons of coal were used in the manufacture of gas and coke in this country; something above 16,000,000 tons being carbonised in gas works. In Germany the total quantity carbonised was 62,613,000 tons; only about 9,000,000 tons being used in gas works. There is, however, a difference of considerable importance so far as the utilisation of products is concerned, that whereas in the United Kingdom 42·7 per cent. of the total coal carbonised is treated in gas works, primarily for the production of coal gas, in Germany the corresponding figure is only 14·4 per cent., the larger bulk being treated primarily for the production of coke.

Owing to the larger proportion carbonised in ovens in Germany, the quantity of some crude products which are of primary importance in chemical industries—such as benzol, which is recovered only to a very small extent in gas works—is very much greater in Germany, relative to the total amount of coal carbonised, than in the United Kingdom. The output of pig iron, which dominates the question of coke production, is clearly an important factor. Germany derives a further advantage from the more extensive use of by-product recovery plant.

Benzol recovery is now a matter of national importance, since toluene, which forms from 10 to 25 per cent. of the benzol, is in large demand for the manufacture of trinitrotoluene. In recovery oven practice the gas is stripped of the whole of the benzol content, but in gas making only the toluene content of the benzol is removed permanently from the gas. It has been proved, however, that at least one-third of the benzol content of the gas can be removed without reducing its calorific value below the standard of 500 B.Th.U. per cubic foot. The possible supply from coke ovens, if the whole of the gas produced in them were debenzolised in recovery plant, would probably amount to 60,000,000 gallons; in addition, by the removal of one-third of the benzol from coal gas, allowing the average benzol to be 2·25 gallons per ton of coal, another 12,000,000 gallons would be obtained. These supplies are independent of the small quantity in coal tar. Mr. Butterfield estimates that some 5 gallons of pure benzene and 1·5 gallons of pure toluene are obtainable from this source per 100 tons of coal carbonised.

Benzene, toluene and xylene, which are obtained from the heavier fractions of benzol and the lighter fractions of naphtha, are the raw materials from which many nitro-compounds are produced for the manufacture of explosives, and for the preparation of bases such as aniline, toluidine, xylidene, etc., which are the starting points for the manufacture of large classes of dye-stuffs and drugs. Congo red, indigo, the large number of aniline dye derivatives, fuchsine, and eosine, are among the most important of the derivatives of the benzene hydrocarbons. Nor must the heavier oils be overlooked. Phenols yield valuable disinfectants, and phenol itself is the raw material for the manufacture of salicylic acid, many dye-stuffs, and the important explosive picric acid (Lyddite). Naphthalene and anthracene are both important as parent bodies from which valuable dyes are prepared.

Referring to the production of trinitrotoluene, Mr. Butterfield mentions that great stores of this explosive had been accumulated in Germany prior to the outbreak of war, and that for one or two years prior to the commencement of hostilities its shipment to this country appears to have been hindered, on the ground of its being dangerous. Without a powerful detonator there is, however, no danger in shipment.

The problem of the establishment of the synthetic colour and drug industries in this country on a scale commensurate with our own requirements is considered briefly. The author sees no inherent objection to the directorate of such an undertaking consisting wholly of financiers and business men, providing that the control of the working is delegated to an advisory or managing board constituted of technical chemists, with at least one engineer accustomed to the design and supervision of works plant. These industries appear to offer ample scope for the investment of capital, with ultimate prospect of very high returns on the investment.

THE MANCHESTER MEETING OF THE BRITISH ASSOCIATION.

THE meeting of the British Association, to be held in Manchester next September, will present some novel and some exceptional features. The special encouragement that will be offered this year to the large class of students and teachers of the district in which the meeting is held, to join the association by offering them associates' tickets at a reduced fee is a novel feature which, if it proves to be successful, may be repeated in future years. The reduction in the number of days over which the meeting extends, the absence from the programme of the formal excursions to which the members are accustomed, and the omission of garden parties and some of the evening entertainments, are exceptional features which have been necessitated by the circumstances arising from the war.

After the outbreak of war some discussion arose as to the wisdom of holding the meeting at all this year. The decision to hold the meeting was reached after consultation between the council in London and the local executive committee. There was some difference of opinion, but, by a very large majority, it was decided that the opportunities afforded by the British Association for the discussion of scientific matters and for the conference of men of science are of such national importance, at the present time, that the meeting ought not to be abandoned.

At the same time it was felt—and on this point there was unanimity—that many of those features of the association's meetings which are of the nature of social entertainment and festivity would be out of place, and should be reduced to a minimum.

Since this decision was reached, great efforts have been made, under the leadership of distinguished men of science in the country, to organise the resources that British science affords for the most pressing services of the State. This organisation should include not only the branches of science that deal with the direct physical, chemical, and technological problems bearing upon the conduct of the war, but also with those that deal with the educational and economic changes the need for which the war has demonstrated. Proper organisation of our forces is undoubtedly essential, but no less essential is the provision of opportunities, such as the meetings of the British Association afford, for the public and private conference of our experts from all parts of the British Isles. It is anticipated, therefore, that the decision of the council and local executive committee to hold the meeting will meet with a hearty response from the scientific men of the country, and there is reason to believe, from the names that have already been sent in, that the meeting this year will prove to be one of the most interesting and memorable in the history of the Association.

The first important change in the arrangements that will be noticed is that the whole business of the meeting will be included in the week beginning September 6. The inaugural meeting will be held in the Free Trade Hall on Tuesday evening, September 7, and the final meetings of the sections on Saturday morning, September 11. For the first time in the history of the association, therefore, there will be no British Association Sunday.

Prof. Schuster, Sec.R.S., the president-elect, will deliver his address at the inaugural meeting on Tuesday evening, and in the same hall on Thursday evening Mr. H. W. T. Wager, F.R.S., will deliver a discourse on the behaviour of plants in response to light, and on Friday evening Dr. R. A. Sampson, F.R.S., will deliver a discourse on a census of the sky.

On Wednesday evening the members and associates are invited to visit the Manchester School of Technology, and to inspect the appliances and apparatus with which this great institution is provided.

The reception room will be the Whitworth Hall of the University, and accommodation will also be provided for all the sections (except Sections F, L, and M), for all the committees, for writing rooms, smoke rooms, and refreshments within the University precincts.

For the convenience of men of business in Manchester, Section F (Economics) will meet in the Chamber of Commerce in Mosley Street. Sections L and M will meet in the High School for Girls in Dover Street, a few yards from the University buildings.

Although there will be no long-distance excursions of the usual type, some shorter excursions will be arranged of special interest to members of particular sections. There will be, for example, some afternoon excursions to places of geological interest for members of Section C, and some short-distance botanical excursions for members of Section K. Arrangements will be made for the visit of some of the members interested in antiquities to Ribchester to attend the formal opening of the new Roman Museum, and on another occasion there will be an excursion to visit the Manchester Ship Canal.

Opportunities will be afforded in the course of the week for members to visit some of the more interesting works, warehouses, and factories of the district, but, owing to the circumstances of the war, the great armament factories, some of the chemical works, and businesses engaged in the manufacture of munitions of war, are unable to offer this year similar invitations to the association.

The Rylands Library, Chetham Hospital, the Art Galleries, and other institutions of special interest, will be opened to members of the association during the meeting.

In the house of the Manchester Literary and Philosophical Society, members of the association will be able to inspect a series of original diagrams made by John Dalton at the beginning of the nineteenth century to illustrate his lectures on the atomic theory. These diagrams have quite recently been discovered in the premises of the society, and have been cleaned, catalogued, and displayed for the inspection of the members. In addition to these diagrams, visitors may see an interesting collection of the instruments, apparatus, and personal effects of John Dalton, and some of the apparatus used by J. P. Joule in his experiments on the mechanical equivalent of heat.

The association has arranged for a number of lectures by distinguished men of science for working-men audiences in Manchester and some of the neighbouring boroughs during the week. The programme of these lectures will be issued shortly.

S. J. H.

NOTES.

THE council of the Physical Society of London has decided to sanction and adopt the letters F.P.S.L. as the official indication of fellowship of the society.

WE regret to see the announcement of the death, at Pretoria, on June 28, aged forty-six, of Mr. Herbert Kynaston, director of the Geological Survey of the Union of South Africa; also, on June 6, at Calcutta, of Mr. H. S. Bion, assistant superintendent, Geological Survey of India.

THE second International Conference of the Society for Practical Astronomy will be held on August 16, 17, and 18, at the University of Chicago, Chicago, Ill., U.S.A. All persons interested in astronomy, and friends of the science, whether members of the society or not, are cordially invited to attend the regular sessions of the conference, and will be made welcome there. The programme will consist of papers from members, illustrated lectures on astronomical subjects, and social meetings. For at least two of the evenings excursions have been arranged to the Dearborn Observatory of Northwestern University, in Evanston, Ill., and to the (private) Petrajtys Observatory, in South Chicago, Ill.

THE death is announced of Prof. J. F. Eykman, of Groningen, at sixty-four years of age. After studying at Amsterdam and at Leyden, and qualifying as a pharmaceutical chemist, Prof. Eykman was appointed director of a hygienic and chemical laboratory at Nagasaki, Japan; later he became professor of chemistry in the University of Tokyo. In 1885 he founded, in the Buitenzorg Botanic Gardens, a laboratory for the chemical and pharmacological investigation of East Indian plants, but returned to Holland in the next year, being succeeded by the late Dr. M. Greshoff. Since 1897 he had occupied the chair of organic chemistry in the University of Groningen. Prof. Eykman was largely responsible for the compilation of the first Japanese Pharmacopœia. His name is further associated with the so-called depressimeter—a simple apparatus for cryoscopic molecular weight determinations.

EXETER COLLEGE, University of Oxford, which has already suffered a severe loss by the death of Dr. Jenkinson in the Dardanelles, has now been deprived of another of its members who had added to his work as a teacher the experience gained by investigation in a wider field. Capt. C. F. Balleine, a native of Jersey, entered Exeter College as a classical scholar in 1902. After a successful academic career, he took his degree in 1906, and was then elected to a senior scholarship in the same college "for travel and research." Having spent some time in Germany, he joined Dr. Randall MacIver in an archæological investigation at Korosko in Upper Egypt. His work on that site was cut short by an attack of appendicitis, on recovery from which he returned home. Having been elected to a tutorial fellowship, still at his old college, he devoted himself assiduously to promoting the welfare, both mental and physical, of the students under his charge. Always keenly interested in military matters, he was a most efficient officer in the Oxford O.T.C. Soon after the war broke out he obtained a commission as captain in the Rifle Brigade, and went to the Front in April. On July 2 he was killed by a shell in Flanders, to the great grief of all who knew him. It is unfortunate that his opportunities for original work were not greater. There is little doubt that, had circumstances favoured, he would have attained high distinction in this direction.

The joint session of the Aristotelian Society, the British Psychological Society, and the Mind Association was held on July 3 and 5. On July 3 Prof. Dawes Hicks presided, and an interesting discussion took place between Prof. G. F. Stout and Mr. Bertrand Russell. It was opened by a paper in which Prof. Stout criticised adversely the theory of judgment as a multiple relation put forward by Mr. Russell in "Problems of Philosophy" as a solution of the problem of truth and error. Mr. Russell now declared that he was himself dissatisfied with the theory and could not defend it, though not for the reasons brought against it by Prof. Stout. He still found himself in profound disagreement with the latter on the fundamental question of the nature of universals. On July 5 Prof. Percy Nunn presided. The meeting was devoted to the discussion of a symposium on "The Import of Propositions," by Miss Constance Jones, Prof. Bosanquet, and Dr. Schiller.

The greater part of a very large skeleton of the Pleistocene southern elephant (*Elephas antiquus*) has been discovered in a river terrace in the grounds of the Royal School of Military Engineering at Upnor, near Chatham. The specimen was buried in stiff clay, and all the remains are well preserved except the comparatively fragile skull. By permission of the War Office and the commandant of the school, and with the valuable help of Capt. H. L. Bingay, the geological department of the British Museum (Natural History) has been engaged for some time in excavating the skeleton, and the work is now nearly completed. One of the preparators of the museum, Mr. L. E. Parsons, has hardened and packed the bones under the direction of Dr. C. W. Andrews, and the collection will shortly be sent to the museum for final preparation. The skeleton is so nearly complete that it can probably be mounted, when it will rival, if not exceed in size, the great skeleton of *Elephas meridionalis* in the Paris Museum, which measures about 14 ft. in height at the shoulder.

The Ipswich Museum has for some time past made a very strong feature of the department of prehistoric archæology, and has collected extensively from the uniquely rich district of East Suffolk. The museum collections now include a large and representative series of pre-Palæolithic and Palæolithic flint implements, and also numerous examples of specimens referable to the later Cave and Neolithic periods. Among the later additions may be noted a large series of implements, bones, etc., from the Grimes Graves flint mines, Moustier flints from Baker's Hole pit in the Thames valley, and implements of different ages presented by Dr. A. E. Peake and Rev. H. G. O. Kendall. The museum authorities have just purchased the entire series of local specimens, and the Palæolithic implements from the Dovercourt gravels collected by the late Lieut.-Col. Underwood, of Ipswich, and these make a very valuable addition to the collections. The skeleton of the Neolithic (or early Bronze age) youth found with an ornamented drinking vessel by Mr. Reid Moir at Wherstead, near Ipswich, is now on exhibition, together with other interesting human skulls, and the remains of extinct animals.

The award of the Hanbury medal to Mr. E. M. Holmes, curator of the Pharmaceutical Society's Museum, for high excellence in the prosecution of original research in the natural history of drugs, is a fitting recognition of Mr. Holmes's unwearied activities in the domain of pharmaceutical and botanical science. In 1897 Mr. Holmes was the first recipient of the Flückiger medal, and his numerous contributions to pharmacography and botany up to that date are enumerated in the *Pharmaceutical Journal* of September 4, 1897. Since then he has contributed about two hundred articles and notes to the journal, and has also found time to continue his studies of the algæ, and of the British seaweeds in particular, of which group he is recognised as one of the first authorities. Among plants of pharmaceutical importance which have been the subject of Mr. Holmes's researches may be mentioned, in particular, jaborandi, Siam benzoin, strychnos, Natal aloes, cinchona, plants yielding myrrh, resins, etc. Plants yielding arrow poisons and plants which are the sources of poisonous drugs generally have been the subject of Mr. Holmes's careful and critical investigation, and pharmaceutical science is deeply indebted to him for the valuable work he has done in connection with medicinal plants and their products. It is largely owing to Mr. Holmes's wide botanical knowledge that his contributions to pharmacography rest on so sure and certain a foundation.

On June 30 (June 17, old style) Dr. Alexander Fischer de Waldheim, director of the Imperial Botanic Garden of Peter the Great at Petrograd completed the fiftieth year of his scientific and administrative activities. The event was made the occasion of a fitting ceremony with presentation of addresses, etc., in the hall of the herbarium at the garden. Dr. Fischer de Waldheim commenced his botanical career as *privat-docent* at the University of Moscow, and later became professor of botany at the University of Warsaw. On the death of A. F. Batalin in 1897 he was appointed director of the gardens at Petrograd. It will be remembered that in 1913, on the 200th anniversary of the founding of the Petrograd garden by Peter the Great, the name of the institution was changed by rescript of the Emperor to that of the Imperial Botanic Garden of Peter the Great, and a representative scientific gathering took place at Petrograd on the occasion. Under the present director's able administration the garden has been greatly improved, and the scientific activities of the institution largely extended. With its museum, herbarium, and library, laboratory, seed-control station, and school of horticulture, the Imperial Botanic Garden forms a very complete institution, and its scientific publications are of the first importance.

ANNOUNCEMENT is made that the board of directors of British Dyes (Limited) is establishing a Research Department, and has invited Dr. G. T. Morgan, F.R.S., of the Royal College of Science for Ireland, Dublin, to become the head of the department. The board has resolved to appoint a Technical Committee, which will consist of Dr. M. O. Forster, F.R.S. (chairman), Dr. J. C. Cain, Dr. G. T. Morgan, F.R.S., and Mr. J. Turner. An Advisory Council, under the chairmanship of Prof. Meldola, F.R.S., is also to be appointed, and the following gentlemen have been invited to become members:—Prof. J. N. Collie, F.R.S., University College, London; Prof. A. W. Crossley, F.R.S., King's College, London; Prof. Percy F. Frankland, F.R.S., the University, Birmingham; Prof. A. G. Green, F.R.S., the University, Leeds; Prof. G. G. Henderson, Royal Technical College, Glasgow; Prof. J. T. Hewitt, F.R.S., East London College, London; Prof. F. S. Kipping, F.R.S., University College, Nottingham; Prof. A. Lapworth, F.R.S., the University, Manchester; Prof. A. G. Perkin, F.R.S., the University, Leeds; Prof. W. H. Perkin, F.R.S., the University, Oxford; Prof. W. J. Pope, F.R.S., the University, Cambridge; Prof. J. F. Thorpe, F.R.S., Royal College of Science, South Kensington; and Prof. W. P. Wynne, F.R.S., the University, Sheffield. The members of the Technical Committee will *ex officio* be members of the Advisory Council.

BRIGADIER-GENERAL T. E. WILCOX has published in the *Sunday Oregonian*, Portland, of May 9, an account of an expedition made in 1883, in which he took part, for the exploration of the Great Plateau of the Columbia, a region occupying approximately 22,000 square miles in the Washington State. It seems once to have formed the bed of Lake Lewis, whose waters were in early times held back by the mountain masses now broken through at the cascades of the Columbia. The original native population was swept away by smallpox introduced by the voyageurs of the Hudson Bay Company, and only a few remain, who live mostly by hunting and trapping.

THE *National Geographic Magazine* is dealing in succession with the areas involved in the great war. In the June number an interesting account by Mrs. F. C. Albrecht of the frontier cities of Italy is very timely. Much attention is naturally given to the architectural glories of Verona, with its Duomo and the statue of Madonna Verona looking down on the women haggling over their vegetables in the marketplace. In a second article Karl Stieler describes Venice, and we can only express a hope that its buildings may be saved from Zeppelin attacks. The number contains eighty-seven superb photographs and two maps, and supplies an admirable account of a lovely country now involved in the perils of war.

THE *Indian Journal of Medical Research* for April (vol. ii., No. 4) contains several papers of considerable interest in tropical medicine and pathology. Major Christophers deals with the nature and significance of the spleen rate and other splenic indices, with a mathematical analysis of the data. A note of some importance by Major Greig deals with a case of infection of a reservoir of drinking-water in Calcutta through a cholera "carrier," *i.e.*, a native who, though well, harboured the cholera microbe. Owing to systematic bacteriological examination of the water, the infection was detected, and the source of it, the "carrier," was found and isolated.

THE National League for Physical Education and Improvement held a meeting at the Mansion House on Tuesday, July 6, to inaugurate a campaign to prevent the spread of epidemics by insects in war time. A series of six lectures upon the subject commenced on July 12. Lectures have also been given at the Child Welfare and Mothercraft Exhibition at the Passmore Edwards Settlement, and the importance of the fly as a disseminator of infantile disease has been emphasised at the exhibition. The Zoological Society's exhibition on the fly continues, and a lecture will be given at the society's office every Wednesday from July 14 on methods of controlling flies. The lectures are open to the public, and tickets can be obtained free on application to the society. Prof. H. Maxwell-Lefroy is responsible for the statement that flies are increasing rapidly, and in his lecture will deal with methods of control; the next three months will be important, and already the blow-fly has become an intolerable pest at the Front. Local exhibitions and lectures are being organised at Nottingham, Reading, Cardiff, and other places, and the public interest in this problem appears to be increasing.

THE *South African Journal of Science* for June contains an article by Mr. C. W. Mally, which shows the good results obtained with poisoned bait in controlling house-flies. The bait used is made up of one pound of sodium arsenite with ten pounds of sugar and ten gallons of water; experience proves this to be an extremely effective poison for the house-fly out of doors, and only a few applications are needed. The liquid is applied with a syringe to non-absorbent surfaces, to pieces of canvas, to manure heaps and rubbish tips. Bunches of twigs, of trees the leaves of which when plucked do not crinkle and drop off, are dipped in the solution and hung up where the flies congregate; the flies drink the poison and die literally in heaps. In military camps the method has been applied with success, and, in the absence of suitable trees, pieces of canvas have been sprayed and hung up, and the bait has been sprinkled near manure heaps and other places where flies gather; the bait is, of course, a human poison, but in military camps there is no risk in its use. The only alternatives, in Mr. Mally's opinion, are the accumulation of all manure in constructions from which flies cannot escape, or the treatment of all manure heaps with chemicals to prevent flies breeding. The first is expensive, though useful, because the enclosures can be so made as to let flies in but not out, the manure thus serving as a trap; the second is impracticable, because so little is known about it. In South Africa the use of arsenical baits for fruit flies has shown that an apparently reckless use of arsenic is not attended with risk to human beings; the poison bait method is therefore adopted where in England the fear of the consequences would prevent its even being considered. Mr. Mally emphasises the cheapness, simplicity, and effectiveness of the method, and demonstrates its value in military camps especially.

The Natural History Department of the British Museum has lately issued another (No. 12) of the handy little sets of "Instructions for Collectors," the subject of the pamphlet being "Worms," in a wide sense, the groups mentioned and illustrated ranging zoologically from the Cestoda to Balanoglossus. The localities where specimens of various classes and orders may be looked for, and the best way of collecting, killing, and preserving them are clearly explained. Especial attention is directed to the desirability of obtaining parasites, and the beginner is warned of the possibility of his meeting with worm-like parasites that are not worms—such as Pentastoma and various Crustacea. The "instructions" have been drawn up by Mr. H. A. Baylis; they will be useful to all museum officers who can set collectors at work in securing zoological specimens, whether at home or abroad.

When the Zoological Society of Scotland was founded, for the purpose of establishing a zoological park, war-clouds had not even begun to form. When the storm burst on us the society had but just come into being. The council, then, is to be congratulated on being enabled to announce, in its second annual report, that all things considered its record is a very satisfactory one. Though naturally seriously hampered just now for lack of funds, progress is still being made in the housing of the animals. The results so far obtained in this direction in many cases surpass anything yet accomplished, either in London or Dublin. This success is due, in part, to natural advantages of environment, and in part to the possibility of improvement on the models of the older institutions. The admirable "acclimatisation house," for example, was modelled on the new small mammals' house of the London Zoological Gardens. From the beautiful photographs which appear in this report, it is plain that the gardens at Edinburgh have set a standard of housing that will be difficult to follow, at any rate from a spectacular point of view.

A valuable contribution to the knowledge of the sperm whale (*Physeter macrocephalus*), based on the study of a fœtal specimen, is made by Dr. F. E. Beddard in the Annals of the Durban Museum, vol. i., part 2. Having regard to the high degree of specialisation which characterises the adult, it is not surprising to find that this specimen—which measured but 20 in. in length—presents many striking points of likeness to the pigmy sperm whale (*Kogia breviceps*), and the more generalised Delphinidæ. Such were particularly noticeable in regard to the head, which, in the first place, was strikingly small in comparison with the rest of the body, since it measured but one-quarter instead of one-third of the total length, which is the proportion in the adult. In old bulls, especially, the upper much overhangs the lower jaw; in this fœtus the snout did not project beyond the mandible, though the characteristic truncation was already complete. While in the adult but one nostril (the left) persists, in this specimen Dr. Beddard found unmistakable vestiges of the right also. In regard to the paddle, it is to be hoped that Dr. Beddard will soon publish a figure of the dissected limb, since in the adult the terminal phalanges enclosed within the apex of the limb are commonly wanting, from what cause remains to be discovered. Some important observations are also included in this memoir on the anatomy of the lungs and intestines, which raise some difficult morphological points not likely to be solved in the immediate future.

Mr. E. D. Merrill continues his descriptions of new or noteworthy Philippine plants in vol. x., No. 1, of the *Philippine Journal of Science*. Ninety new species belonging to thirteen natural families are described; the genera Aquilaria, Koompassia, Melilotus, Neptunia, Cymodocea, Diplanthera, Hanguana, Urceola, Vallaris, and Protium, are recorded for the first time from the archipelago.

In an article in the *Indian Forester* for May an account is given of experiments made to test the power of germination of teak seeds when sown (1) after charring in a forest fire, (2) untreated, and (3) after being soaked in cow-dung fifteen days. The charred seeds collected from a burnt teak forest germinated profusely within a fortnight of sowing, and it is suggested that the best means of ensuring regeneration of teak is to prepare raised seed beds in burnt areas where teak is to be planted, and to sow charred seeds therein. Teak seedlings tend to die in large numbers if they have to be transported for long distances.

Kew Bulletin No. 4 is mainly occupied by an important paper on "Some Additional Species of Meconopsis," by the director, Sir David Prain, who is the authority on this interesting genus of Papaveraceæ which form so striking a feature of the flora of the Himalaya, Thibet, and Western China. This, the third monographic account of the genus by Sir David, has been necessitated owing to the introduction of several new species from China, and to the remarkable enthusiasm displayed by cultivators both in the formerly known Himalayan species and in those recently discovered by Messrs. Forrest, Ward, and Captain Bailey. In 1896 the number of known species was 23; in 1907 it had risen to 27, and now 40 species are recognised. In the paper a key has been drawn up for all the species, and the new species are described. Visitors to the Royal Botanic Gardens, Edinburgh, have been rewarded by seeing many of the species growing to perfection, especially those with brilliant blue flowers, and in the rock-garden at Kew there has also been a good display of several interesting species during the late spring.

It has long been recognised that when an earthquake originates beneath the ocean and is accompanied by a large displacement of the ocean floor, waves on the surface of the sea necessarily result. Such a series of "tidal waves" (as they are generally but erroneously called) overwhelmed the north-east coast of Japan in 1896; and certain features as observed at Miyako suggested to Messrs. K. Sano and K. Hasegawa the investigation of the following hydrodynamical problem: on the wave produced by the sudden depression of a small portion of the bottom of a sea of uniform depth. This they show to be nearly the same as a somewhat different problem in which a small part of the surface is subjected to a short-lived impulsive pressure. The numerical calculations are long and laborious, and a comparison of the results of the calculation with what was observed at Miyako lead to the following conclusions:—(1) There is good agreement between the calculated and observed time intervals from the beginning of the earthquake to the arrival at Miyako of the first wave crest; (2) there is a fair agreement between the calculated and observed time intervals from the beginning of the earthquake to the arrival of the second wave crest; (3) calculation and observation agree in assigning the greatest crest to the second wave. The paper is published in the Bulletin of the Central Meteorological Observatory of Japan, vol. ii., No. 3, 1915.

REMAINS of the gigantic horned dinosaurs from the Upper Cretaceous formations of Alberta, western Canada, have been collected so assiduously during the last few years, both by Canadians and Americans, that it is now possible to realise how numerous and varied were these strange land-reptiles. While describing a new genus, Eoceratops, which he thinks may be ancestral to many of the others, Mr. Laurence M. Lambe has just published a tabular synopsis of the group, defining the various forms that seem to be distinguishable (Canada, Geological Survey, Museum Bulletin, No. 12, Geological Series, No. 24). Sometimes the great bony frill over the neck is continuous, sometimes it is pierced with vacuities; while the shape and size of the bony bosses round its rim are remarkably varied. There seems to have been a tendency in the horned dinosaurs to produce a separate bony boss on each prominence of the upper part of the skull, and scarcely any two specimens are alike. The nasal horn-core proves to be especially complex, being formed of the tips of the two nasal bones fused with a pair of superposed bony bosses. In one of the newly discovered skulls this nasal horn-core is in the shape of a forwardly turned hook. Mr. Lambe's paper is illustrated by numerous drawings of important specimens in the Canadian Geological Survey collection at the Victoria Memorial Museum, Ottawa.

THE Department of Revenue and Agriculture of the Government of India has issued a memorandum on the meteorological conditions prevailing in the Indian monsoon region before the advance of the south-west monsoon of 1915, with an estimate of the probable distribution of the monsoon rainfall in 1915. The memorandum has been drawn up by Dr. G. C. Simpson. A clear statement is given of each factor supposed to have a controlling influence on the conditions. High pressure over South America during the period March to May is found to be favourable to the monsoon; the conditions under this head are said to be distinctly unfavourable. Low pressure in Australia, Indian Ocean, and Africa in May is favourable to monsoon rainfall in India, while a deficiency in rainfall at Zanzibar and in the adjacent parts of East Africa also has a good effect; the conditions in this region are said not to be sufficiently pronounced to exert any marked influence. The effect of an excess of snowfall accumulation upon the monsoon rainfall of India as a whole is to diminish it in the early portion of the season; while no effect on the rainfall of August and September can be detected; it is estimated that the snowfall is not likely to exert a prejudicial effect on the monsoon, but the prolongation of the winter conditions may indicate the late arrival of the monsoon and unsteadiness during the first part of the season. The conclusion arrived at is that while the monsoon of 1915 may not be so good as that of 1914, there are no indications of a serious deficiency in the total rainfall. The Arabian Sea current is likely to be less active than the Bay current.

IN a paper on the temperature coefficient of magnetic permeability of irons within the working range, which appeared recently in the Journal of the Bureau of Standards, Mr. R. L. Stanford directed attention to the necessity of either working at a standard temperature, or determining the temperature coefficient of the actual material under test if results accurate to within 1 per cent. are to be obtained. On testing a number of rings of cast-iron, wrought-iron, and low carbon steels of about 10 cm. diameter and radial depth 0·5 to 1 cm. at temperatures between 3° C. and 88° C., he found that before consistent results could be obtained it was necessary artificially to "age" the specimens by heating and cooling them a number of times. This process generally necessitated the use of about 15 per cent. more magnetising force to produce the same induction—2000 to 16,000—in the aged specimen. For such specimens he finds that the temperature coefficient of permeability may be as high as 0·3 per cent. per degree, and that a neglect of the temperature effect may in a rise of 10° C. to 20° C. produce an error of 2 per cent. or more.

IN a paper published in the *Journal of Physiology* for May 12, on the simple character of the yellow sensation, Dr. F. W. Edridge-Green brings forward, in a collected form, various arguments which have been urged in favour of this sensation being simple in contradistinction to the theory of Young-Helmholtz, which asserts that it is a sensation compounded of simple red and green. The chief support of the latter statement is the fact that a spectral yellow can be exactly matched by a superposition of red and green. Dr. Edridge-Green urges, however, that "it is wrong to assume that the physiological sensations are similarly constituted." In many of the experiments that have been made by other observers coloured papers have been employed instead of spectral colours. Even the most superficial experimentalist will now admit that this practice robs the results of definite scientific meaning. Dr. Edridge-Green has studiously kept to spectral colours, and his results deserve close attention. Amongst many other results he adduces the following:—(1) If the eye be fatigued with pure yellow spectral light the spectrum will appear to have lost its yellow, but the terminal red of the spectrum will not be affected. (2) If the eye be fatigued with red light even by looking through a red glass held against a light for one second, the red in the spectrum will not be visible for some considerable time, but the eye may be fatigued for twenty minutes with yellow light without interfering with the visibility of the red light. (3) The eye may be fatigued with red or green without altering the hue of spectral yellow. This may be shown by wearing red or green glass spectacles which are transparent to yellow. (4) When a sodium flame is viewed after fatigue with spectral red light it is very little affected in the region of the after-image, though the green-blue after-image is very strongly marked on either side of the sodium flame, when the after-image is larger than the flame. The fundamental phenomena of colour sensation are still very obscure. Perhaps the most difficult fact to explain away is the obvious simplicity of *white*, if it be indeed true that it is compounded of many tints.

Bulletin No. 1 of the Chemical Section of the Wellcome Tropical Research Laboratories, Khartoum, contains a paper on the estimation of methyl alcohol in the presence of ethyl alcohol, by Mr. W. A. R. Wilks; in this paper the standard process of Thorpe and Holmes is slightly modified so as to increase the degree of accuracy. Bulletin No. 2 is a discussion of the applicability of papyrus to paper manufacture by Dr. W. Beam; it is concluded that after allowing for the collection and transport of the papyrus to Europe, there is a margin for profit for this substance as a raw material in the paper industry. Bulletin No. 3, by Dr. Beam, deals with tests for hashish, more particularly the test which depends upon the fact that the resinous matter, "cannabinol," of hashish produces a rich purple colour on treatment with a small amount of caustic alkali. The principal point to which attention is directed is that the extract of *Cannabis indica* does not usually respond to this test; the influence of soil, climate, method of cultivation, and curing seems to have much greater effect on the chemical composition of this plant than has hitherto been suspected.

Prof. F. C. Lea and Mr. W. Norman Thomas have an article in *Engineering* for July 2 on the change in density of mild steel strained by compression beyond the yield point. Experiments were undertaken with a view of ascertaining how far changes of density occur in overstrained mild steel, and whether any change in density occurs with time after the straining-load is released. Preliminary experiments definitely indicated that a change of density was brought about by overstraining, and that the time factor was important. Until this was recognised it was difficult to get consistent results. For results to be comparable two conditions must be observed. First, if the specimens are loaded considerably beyond the yield point, the final loads must be kept on the specimens for the same time; in other words, the amount of strain, and thus the change in density, are dependent upon the time of loading. Secondly, the densities should be determined as soon after the loading as possible. Results show that an increase in density occurred during a rest period of from thirty-five to thirty-eight days after the load had been removed. Experiments are suspended meanwhile as Birmingham University is in use as a hospital.

We have received from Messrs. Charles Baker a catalogue of microscopes and accessories, all of which are manufactured at their factory in London. The list includes several new models, amongst which are three instruments similar to the Continental designs, the prices of which compare very favourably with those quoted abroad. Another instrument of interest is "the workshop metallurgical microscope." The catalogue is well produced and copiously illustrated.

OUR ASTRONOMICAL COLUMN.

The Structure of the Universe.—If the distance of each star were known in addition to its position in the sky, our knowledge of the present structure of the universe would be complete. In order to determine the change in the structure, it would be only necessary to know the motions of the stars. We know the positions of a great number of the stars and their motions across the line of sight; we know also the velocities in the line of sight of a few, and the distances of a still smaller number. The data for the solution of the problem are therefore very meagre. Nevertheless, there are indirect methods of attacking the problem which may tend to lead one to an approximate solution, and it is these methods which form the subject of the very instructive article which appears in the July number of *Science Progress* by Mr. H. Spencer Jones, of the Royal Observatory, Greenwich. The idea, as he states, that the centre of our system is occupied by an immense sun, many thousands of times larger and more glorious than our own sun, and that round about it are millions of lesser suns of various sizes, together forming the nucleus of an immense spiral nebula, of which the spiral arms coiling around the nucleus appear to us as the Milky Way, and that this to us immense system is but one, and perhaps a comparatively small, island universe amongst thousands or millions of other island universes in space, is an idea which by its magnificence appeals to the mind of man. What forms the substance of the article is the basis of truth upon which this conception is founded, and the straightforward and clear way in which the author has marshalled his evidence makes the article of particular interest.

The Nebulous Region near Omicron Persei.—It is due to photography and the portrait lens that our knowledge of the large diffused nebulæ and the dark regions of the sky has been gained, and it was only recently that Prof. E. E. Barnard's work in this field was referred to in this journal. Attention is now directed by him to the great nebulous region near Omicron Persei (*Astrophysical Journal*, May), a photograph of which he describes and illustrates. The photograph was specially taken to examine more closely this region for dark or partly luminous matter which produces the apparent vacancies. The attempt was successful after giving an exposure of 6 hours and 41 minutes with the Bruce 10- and 6-in. telescopes. Prof. Barnard describes the photograph in some detail, and points out the association of this region with that of the Pleiades, of which it forms part.

Work at the Lowell Observatory.—Among the many interesting contributions to the *American Museum Journal* (vol. xv., No. 5), two deal with the fine photographic work which is being carried on at the Lowell Observatory, this observatory being situated in Arizona at an elevation of 7250 ft., the finest site of any existing similar institution. The articles in question are on the subjects, "Oxygen and Water on Mars" and "The Photograph in Astronomy," and are written by the director of the observatory, Prof. Percival Lowell and Mr. E. C. Slipher respectively. The illustrations are a distinguishing feature of both communications; they show the great 24-in. refracting telescope and the dome in which it is housed; comparison spectra of the moon and Mars demonstrate the difference in darkness of the water-vapour band indicating the presence of water vapour in the atmosphere of Mars. Photographs of the planets Saturn and Jupiter give one an idea of the great advances made in recording their surface features and satellite phenomena, while the spectrum of the latter planet affords a means of measuring the speed of rotation by noting the slant of the lines. Photographs of nebulæ and comet 1910*a* are included among other illustrations.

THE MUSEUMS ASSOCIATION.

TO associations as to individuals there comes a time of trial, when their worth to the world is tested. The Museums Association, like other bodies, had to be proved by this year of war, and if it hesitated fully to grasp the great occasion, yet it rose not ignobly towards it. Devoted to the arts and studies of peace, it would fain have withdrawn awhile from the turbulence, had not a fortunate rule insisted on at least a general business meeting. Still wishing to be inconspicuous, it chose London as its place of assembly on July 7–8, proposing to do little more than prolong the official life of its officers and council who, it was thought, had been robbed of their opportunities by the war. Happily for the association, some wider imaginations took a stronger line, and determined to show that the association and its constituent museums could now serve the nation better than ever. Happily, too, the hospitality of the Victoria and Albert Museum, gracefully offered by the Board of Education through Sir Cecil Smith, dragged the conference from its self-sought obscurity.

At the outset the dominant note was struck by Dr. Bather (Natural History Museum), Mr. Butterfield (Hastings), and Mr. G. W. Prothero (Central Committee for National Patriotic Organisations). Both now and for a long future the situation is changed, and museums, they said, must meet it. Working by their special methods, they can stimulate enthusiasm, ward off discouragement, teach people how to help the forces at sea and in the field, how to fight disease and its causes, how to economise with profit to the nation as well as to themselves, how to supplement our food-supply; and, looking further ahead, they can indicate within the Empire sources of supply for our industries, can furnish manufacturers with foreign models, and, above all, can help in the physical and mental upbringing of the coming generation, to whom they must hand on undimmed the lamp of peaceful learning.

The sort of exhibits by which this important work might be accomplished are sketched in an editorial already published in the *Museums Journal* for July. Many of them were dealt with in more detail by speakers in the discussion (especially Messrs. Howarth, of Sheffield, Bolton, of Bristol, Woolnough, of Ipswich, Deas, of Sunderland, and Williamson, of Derby), or formed the subject of separate papers. Thus Dr. Grant Ogilvie (Science Museum) showed how the conditions of life and the earning powers of the community might be improved by a carefully thought-out scheme of exhibits linking up the fundamental principles of science and the elementary materials of art with the industries of each locality; the visitor is more interested in things connected with his daily activities, and the museum sends him back with more intelligent interest in those activities. On the true scientific foundation must be based appropriateness of design, carried out by sound workmanship; and so Mr. H. H. Peach, of the Leicester Art School, expounded the objects of the newly-formed Design and Industries Association, and indicated the help that the museum might best give in its attempt to organise the artistic faculty in union with the technical ability and commercial enterprise of the nation.

As regards industries, museums have also their own interests to serve; glass jars and other apparatus, metal trays and cases, formalin and various reagents, are among the museum material hitherto obtained chiefly from Germany, owing to the inability or unwillingness of British manufacturers to meet the demands of curators. A committee was appointed to approach manufacturers with a statement of probable requirements and to invite tenders. We trust that this committee will consult with those committees of the British Science Guild which are doing similar work (NATURE, July 8, p. 520).

But dearth of men will be a greater danger than dearth of material, and, as was forcibly pleaded by Nurse Prior, museums might well follow the example of Leicester, and devote a section to children's welfare, showing by concrete examples the right and the wrong ways of nursing, feeding, and clothing babies.

And then these children will have to be educated, a task in which the museum will take no small share. Of all peaceful activities the education of the young is the one that most needs to be kept going, and day by day we realise afresh that the thing seen is more forcible than the thing heard.

It was thus most fitting that the conference should conclude with a discussion between museum curators and representatives of the Education Section of the British Association. The case of the educationists was presented in a profound yet lucid address by Prof. Green, of Sheffield, who urged the claims of the children and other uninstructed visitors. For them are not wanted the analysis and system of the specialist, but a free synthetic treatment that shall bring each object into relation with the outer world, and particularly that world which is known to the child. The difficulty raised by Mr. Madeley, that each visitor brings a different world of his own, shows that labels are insufficient to give the synthesis needed for each case. We must have recourse to the human interpreter, and the question is—in what form? The best interpreter ought to be the trained teacher already familiar with the child's mind and world; but, unfortunately, the elementary-school teacher must himself be taught how to use a museum. Two means of effecting this were suggested: Prof. Green would present the teachers with a printed guide, showing them how to utilise the exhibits. Mr. Spurley Hey, director of education for Manchester, had selected the most suitable teachers and handed them over to the directors of museums to be trained as they thought best for the purpose of taking pupils round. This might partly meet the financial difficulties, which were emphasised by Messrs. Bolton and Woolnough. Modes of cooperation between museums and teaching institutions of higher rank were suggested by Dr. Bather, and other solid contributions to the discussion were being made by speakers of varied experience, when the meeting was brought to an abrupt conclusion.

During its first quarter of a century this association has, we gather, proved of service to its members; if now they will act up to the ideals set before them at this twenty-sixth annual meeting, it should prove of no less service to the nation.

THE DAYLIGHT FIREBALL OF JULY 5.

VERY large meteors apparently exhibit a preference for the early evening hours. The fireball of March 28 last came at 7.48 p.m., and a great number of corroborative instances might be cited. The majority of these bodies travel with comparatively slow motion over extensive arcs, and are directed from radiant points in the western region of the heavens.

On Monday evening, July 5, at 8h. 30m., a few minutes after sunset, a splendid fireball passed from west to east in a long and nearly horizontal flight across the southern sky. The weather was generally clear over the south of England at the time, and thousands of observers were fortunate in catching a sight of the meteor as its nucleus disintegrated into a series of glistening balls strung on a fiery cord.

The spectacle was viewed by persons who sent in reports from Gloucestershire, Dorset, Hants, Essex, Somerset and Surrey, but the descriptions are rather indefinite owing to the conditions prevailing at the time. No stars were visible to which the path of the object might be referred. Yet, though daylight was so strong, the meteor brightly illumined the sky and attracted people to look upwards to ascertain the cause.

Mr. W. G. Wallace, of Broadstone, Dorset, writes that his sister saw the meteor in a S.S.E. direction, altitude about 30°. It disappeared over E. by S., altitude 20°. The object presented a brilliant mass of greenish-yellow light, moving slowly, and near the end of its flight it divided into two portions.

Mr. A. G. Pile, of Old Sodbury, Gloucestershire, observed the meteor moving from S.W. towards E. in from four to five seconds. It emitted a bluish-yellow flame, and looked like a large sky-rocket.

Mr. Dick, of Purley, Surrey, states that it quite lit up the sky, and travelled from S.W. to E. by S., about 20° high. It split into two large fragments early in its flight. What specially struck him was the horizontal course, duration about 13 seconds.

Mr. W. J. Allen, of Thornbury, Glos., saw the bright light of the meteor traversing the sky in a horizontal direction from S.W. to E. When first noticed it apparently consisted of three electric balls, but at the end only two could be discerned.

Mrs. L. E. Butter, of Bishops Waltham, Hants, reports that her son, when sitting in the garden, called her to see a bright, comet-like appearance travelling from S.W. to eastward. There was a secondary head merging into the tail. The object finally burst like a rocket.

Mrs. H. I. W. May, of Chadwell Heath, Essex, relates that her daughters saw a brilliant star in the south going from west to east. While watching it the head divided into three stars and then disappeared.

At Bristol the meteor passed from W. of S. to E.S.E.; the angle of descent was slight, motion rather slow, and the nucleus consisted of two balls of fire, the leader being the largest. There was a profuse emission of sparks as the object sailed along, and the duration for the section of the flight which came under observation was six seconds.

Mr. E. W. Barlow writes that at Bournemouth the phenomenon was remarked by various people who could not, however, give exact particulars of the event. When passing due S. the altitude was 40° to 45°, and the motion horizontal. The direction was from west to east.

I have been in correspondence with the various observers and elicited much further information, which has enabled me to derive the real path of the meteor. But the result may possibly require revision on the basis of additional records:—

Fireball of July 5, 8h. 30m.

Radiant point	152°–6°
Height at beginning	57 miles
Height at end	28 „
Length of luminous path	260 „
Velocity per second	20 „
Position over English Channel from...	S. of Plymouth
„ „ „ to ...	Boulogne, France
Number of descriptions	12

The radiant was near the W. by S. horizon, and its position must have been deflected several degrees towards the N.E. by the effect of zenithal attraction.

There is a special reason why so many fine meteors overtake the earth in nearly horizontal courses, and appear in the earlier hours of the night.

W. F. DENNING.

THE MATERIAL BASIS OF EVOLUTION.

THE "Origin of Single Characters as Observed in Fossil and Living Animals" forms the subject of an illuminating essay in the *American Naturalist* for April, by Prof. H. F. Osborn. Since it contains some trenchant criticisms on recent attacks on the evolution theory, and on Darwin's work, it is likely to be much discussed in the immediate future.

The main purpose of his address is to insist on the importance of single characters, or "least characters," as indices of the trend of evolution rather than on the sum of the indefinite number of single characters which make up the individual. "In a sense," he remarks, "the species, subspecies, and variety, and even the individual, is not a zoological unit, whereas the 'character,' when narrowed down to the last point of divisibility, seems to be a unit . . . and a very stable one, with certain distinctive powers, properties, and qualities of its own." This conception of the individual as a complex of separable and independently variable units represents a view which has been gaining ground for some time past.

But Prof. Osborn attempts to systematise this newer conception of the factors to be reckoned with in studying the elusive and complex phenomena associated with the transformation of animals. He distinguishes two aspects of this process—the study of the birth and development of proportional, and of numerical characters. Those of the first category he defines as universal and abundant; they are such as distinguish species and subspecies one from another, and may be germinal and therefore heritable, or merely somatic, due to environmental influences; while numerical characters, on the other hand, are solely germinal.

As numerical characters he cites the number of the teeth and of their cusps, the number of toes and of vertebræ, and so on, such being relatively stable characters which may be shared in common between a large number of species and genera.

That no hard and fast line can be drawn between "proportional" and "numerical" characters Prof. Osborn himself realises, for he uses as an illustration the reduction of the digits, as in the case of the evolution of the horse's foot. Hence it seems difficult to accept his dictum that proportional and numerical characters are due to a different series of direct causes. Rather they seem to be merely measures of degree—quantitative and qualitative.

Towards the latter part of his essay he aims a blow at the Mendelians, and remarks that "If the student of genetics abandons the natural and the normal for the unnatural and the abnormal and sticks solely to his seed pan and his incubator, he is in danger of observing modes of origin and behaviour of characters which never have, and never will, occur in nature." Nor is he less positive that there is no evidence whatsoever in support of the theory that "species" may arise from fortuitous, saltatory characters. This is one of the traditions, he tells us, of the master mind of Darwin that we must abandon entirely. But this, surely, is yet at least a debatable point. Prof. Osborn apparently is convinced that all characters must run the gauntlet of selection. To attempt to defend such a position is to court disaster.

As Prof. Osborn himself maintains, the individual is to be regarded as a complex of unstable units, and this instability is expressed in a tendency to development along new lines of growth. Each unit, in short, has its own individuality and potentialities of development, which are controlled, in the first instance, by the immediate environment—the neighbouring units of the organism—just as the organism as a whole is in turn controlled by the external environment, or by "selection." Where the incidence of the struggle for existence falls lightly, such units may give rise to hypertrophied outgrowths, as, for example, in the train of the peacock, or in the huge wings of the Argus pheasant: where the struggle for existence is severe, ornament and other exuberances of development are suppressed.

Finally, in regard to natural selection and its relation to the origin of characters, Prof. Osborn remarks that we know nothing; hence he seems disposed to regard with something like approval the recent enunciation of Prof. Bateson that we may have to forgo the theory of the addition of germinal factors, or determinants, and substitute the theory of variation by loss of factors.

This theory of evolution by "loss" seems to have captivated many, but surely when the phenomena on which this is based are carefully examined it will be found that the phrase "evolution by loss" amounts to no more than an emphasis of the fact that the evolution of new types is but a more striking phase of the evolution of species. For with types, as with the species which they embrace, the material basis of evolution is afforded by Prof. Osborn's "allometrons" or "proportional characters."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Edinburgh.—At the summer graduation on July 8 Sir William Turner, the Vice-Chancellor, who presided, said the University roll of honour now contains more than 4000 names. Among the honorary degrees conferred were the following:—*Doctor of Laws*: Sir Robert Blair, education officer, London County Council; Prof. W. A. Herdman, University of Liverpool; and Prof. Arthur Thomson, University of Oxford.

The Department of Agriculture and Technical Instruction for Ireland has issued as a pamphlet a descriptive account of the Irish Training School of Domestic Economy. The school is situated at St. Kevin's Park, Kilmacud, Stillorgan, Co. Dublin. The premises stand in grounds of about three acres, in one of the finest situations in South County Dublin. The house provides ample accommodation for the staff and students, in addition to class and recreation rooms. The school is a residential institution, maintained by the Department of Agriculture and Technical Instruction for Ireland, for the purpose of training teachers of domestic economy, and also for providing a training in household management for girls who have received a satisfactory education. The work of the school comprises two courses of instruction—a course of instruction extending over one year in household management, the object of which is to train girls for the management of their own homes, and a further two years' course of training for teachers of domestic economy.

We have received a copy of the report of the council to the members of the City and Guilds of London Institute for the year 1914. The results in the department of technology show that the year 1913–14 was a record year, so far as regards attendance at classes in technology. During the session 5049 classes in technological subjects were registered by the institute in 321 towns, and these classes were attended by 55,996 students, showing an increase of 1486 on the numbers in the previous year. At the examinations, 23,119 candidates were presented in technology, showing an increase of 1241, and by including candidates from India, from the overseas Dominions, and from other parts of the Empire, and for special subjects other than technology, the total number of examinees was 26,776. But the effect of the war has been felt severely in this as in other departments of the institute's work. Four appendices contain detailed reports of the dean on the City and Guilds (Engineering) College, of the principal on the City and Guilds Technical College, Finsbury, on the City and Guilds South London Technical Art School, and on the work of the department of technology, in each case for the session 1913–14.

SOCIETIES AND ACADEMIES.

London.

Physical Society, June 25.—Dr. A. Russell, vice-president, in the chair.—Sir J. J. **Thomson**: Conduction of electricity through metals. The discovery by Kamerlingh Onnes, that at the temperature of liquid helium some metals can exist in a state in which their specific resistance is less than one hundred thousand millionth part of that at 0° C., appears to necessitate the abandonment of the ordinary theory of metallic conduction, as the experimental conditions prohibit the explanation of the phenomenon by an abnormal increase, either in the number or mean free path of the free electrons. The effects observed by Kamerlingh Onnes may, however, be accounted for by a theory of metallic conduction previously given by the author in "The Corpuscular Theory of Matter." On this theory the atoms of some substances contain electrical doublets—*i.e.* pairs of equal and opposite electrical charges at a small distance apart. The effect of an applied E.M.F. is to alter the heterogeneous distribution of the axes of these doublets by bringing them into partial alignment with the field. The function of the applied field is to produce the alignment of the doublets; the actual transference of electricity is effected by the large interatomic forces brought into being by the polarisation of the doublets. Thus, if the polarisation remains on withdrawing the applied E.M.F. the current will also remain.—Lieut.-Col. G. O. **Squier**: An unbroken alternating current for cable telegraphy. (1) The paper proposes a new angle of view in the method of transmission of signals in the submarine telegraph cable, and describes some apparatus for operating on the general principles involved. (2) An ocean cable is considered as a power line, and starting with the standard form of circuit which would be used in case it were required to operate an electric motor through an ocean cable, experiments are described to determine the minimum possible variations required in such a circuit to permit the alternating current received to be interpreted in dots, dashes, and spaces of the present alphabet. The uninterrupted alternating current used in transmission is operated on synchronously by the ordinary transmitting tape, so as to alter the impedance of the transmitting circuit at the instants when the current is naturally zero. Dots, dashes, and spaces are each sent by semi-waves of either sign, but of different amplitudes. The alternating current received may be read directly from the record made by a siphon recorder, or this current may be employed to operate a siphon Morse printer, by means of an adaptation of Muirhead's gold-wire relay, or a Heurtley magnifier and a local wire relay. (3) The voltage stress along an Atlantic cable when an alternator is employed is shown, and the transmitting impedance of such a cable is computed as the frequency varies. (4) A special form of cable dynamo to operate at frequencies from 4 to 10 was used in the experiments described. (5) The fundamental principle is developed of never metallically "breaking" the transmitter circuit, which permits of greater accuracy in balancing the duplex bridge.

EDINBURGH.

Royal Society, June 21.—Prof. Hudson Beare, vice-president, in the chair.—Dr. A. **Lauder** and T. W. **Fagan**: The composition of milk as affected by increase in the amount of calcium phosphate in the rations of cows. In these experiments the amount of calcium phosphate added was gradually increased to 8 oz. per head per day. No increase in the amount of phosphorus or of mineral matter in the milk could be detected, in agreement with the generally received opinion that within wide limits the composition of milk was little affected by the nature of the food fed to the cow.—J. Herbert **Paul**: A comparative study of the reflexes of autotomy. Self-amputation of limbs in the Decapod Crustacea is accomplished in various ways. Thus hermit crabs when removed from their shells usually respond to injury by plucking off the damaged limb with their claws. The "true" crabs possess a specialised mechanism by which the limb is weakened at the breaking plane, so that a very slight force can sever it. In lobsters, a special muscle, by violent contraction, weakens the limb along a groove in the third segment, and immediately the imprisoned limb is left in the grasp of the enemy. If the more highly developed mechanism is disorganised in certain species, the animal returns, as it were, to the ways of its ancestors, and attempts to amputate the injured limb by more primitive methods.—Dr. M. **Young**: A contribution to the study of the Scottish skull. The investigation was based upon a study of more than 700 skulls which have been for some years in the possession of the anatomical department of the University of Glasgow. The greater number were collected by W. K. Hutton, lecturer in anatomy, Queen Margaret College, and were obtained during the excavation of an old Glasgow burying ground. The skulls are in the great majority of cases West Scottish skulls. They are more dolichocephalic than the average of Sir William Turner's series of Scottish skulls, but resemble most closely those in this series which are derived from Renfrewshire. Comparison between the two series has been made by the ordinary method; and the Glasgow collection has also been examined by modern biometrical methods, and the variability, as well as the correlation of the West Scottish skull as regards many of its dimensions and characters, have been determined and compared with those found in other series of skulls. One hundred specimens in the collection were divided in the medial sagittal plane, and from a study of the sectorial diagrams it appears that certain values of features which have been regarded hitherto as of morphological importance in different races fall within the range of variation shown by the large homogeneous West Scottish series. The skulls are similar in type to the "Long Barrow" crania from the chambered caverns of Arran, described by Prof. Bryce, and the Whitechapel English series of crania described by Dr. Macdonnell. They are without doubt those of the descendants of the Iberian or Mediterranean stock or race who have remained in the West of Scotland and have been less influenced by the later brachycephalic type than has been the case in the east of Scotland. Their mean values represent only a type of Scottish skull, but this type perpetuated in comparative purity in the present collection is that which, modified by various factors, has resulted in the diverse cranial form seen in Scotland at the present day.—Dr. **Ashworth** and Dr. J. **Ritchie**: The morphology and development of the free-swimming sporosacs of the hydroid genus Dicoryne; with description of a new species. The sporosacs of *D. parthenopeia* closely resemble those of *D. conferta*, except that they have a single tentacle, and the female sporosac bears only one ovum. The oocytes are differentiated and grow in the ectoderm of a blastostyle in the position which the sporosac will ultimately occupy; there is no migration of oocytes. The sporosac does not exhibit during development any trace of medusoid structure; there is no evidence that this sporosac has undergone regression from the condition of a medusa or medusoid gonophore. The general structure of the colony of *D. parthenopeia*, the regenerative capacity of the stolon, the method of release of the sporosacs, and the early development of the egg are also described.

PARIS.

Academy of Sciences, July 5.—M. Ed. Perrier in the chair.—M. **Giller**: Lightning and telegraph lines. An analysis of certain features common to all telegraph posts struck by lightning, and a suggestion for avoiding damage by the introduction of a spiral resistance possessing self-induction.—Henri **Pénau**: Cytology of the *Bacillus verdunensis*. This new species has been found in water at Verdun, and has some properties in common with the *coli* bacillus, from which, however, it can be separated. Details of various stages of growth are given.—M. **Gard**: A genus of Papilonaceæ, new for cyanogenesis.—Ed. **Crauzel**: The treatment of recent wounds by an expansible solution of iodine. The use of ether containing 5 per cent. of iodine in solution is suggested as offering advantages over the usual alcoholic tincture. It does not change in strength, and penetrates rapidly into wounds.—J. **Cluzet**: A simple method for the electrical examination of paralytics. The apparatus consists of a system of condensers, capacity from 0·01 to 12 microfarads, capable of utilising directly current from lighting mains. The use of the instrument in diagnosis is described.—A. **Policard** and A. **Phélip**: The first stages of the evolution of lesions in wounds caused by war projectiles, with some practical consequences. All fragments of clothing must be removed from the wound at the earliest possible moment. Too free use of antiseptics may diminish the defensive reaction of the tissues in the neighbourhood of the wound.—M. **Billon-Daguerre**: A mode of producing thin sheets of liquids for sterilisation by ultra-violet light.

WASHINGTON, D.C.

National Academy of Sciences, presented to the Academy from April 15 to May 22.—C. G. **Abbot**, F. E. **Fowle**, and L. B. **Aldrich**: Confirmatory experiments on the value of the solar-constant of radiation. Observations at Mt. Wilson from sunrise until ten o'clock, and records obtained by a recording pyrheliometer attached to sounding balloons rising to the altitude of 24 km. confirm the value of 1·93 calories per square centimetre per minute previously obtained for the radiant energy received by the earth from the sun.—T. H. **Goodspeed** and R. E. **Clausen**: Variation of flower-size in Nicotiana. During five years of study of the inheritance of flower-size in Nicotiana it has been found that the flower-size is not so constant as it has been assumed to be, but is affected by a number of conditions, some of which may not affect the length and the spread of the flower in the same manner.—I. S. **Kleiner** and S. J. **Meltzer**: Retention in the circulation of dextrose in normal and depancreatised animals, and the effect of an intravenous injection of an emulsion of pancreas upon this retention. In normal animals the circulation possesses the ability to get rid readily of a surplus of dextrose injected intravenously. This ability is impaired in the absence of the pancreas, but can be temporarily restored by intravenous injections of pancreas emulsion. Such injections, moreover, are capable of reducing the hyperglæmia due only to depancreatisation.—T. H. **Goodspeed**: Parthenocarpy and parthenogenesis in Nicotiana. Mrs. R. H. Thomas found frequent cases of parthenogenesis in Nicotiana; but other experimenters have been unable to verify these results. The present investigation, conducted upon the particular strains of tobacco of which seeds were furnished by Mrs. Thomas, shows that in those strains parthenocarpy is a frequent occurrence, and that parthenogenesis is also peculiar to this variety.—R. H. **Lowie**: Exogamy and the classificatory system of relationship. The exogamous factor must have been a real cause in moulding the kinship terminology of at least some so-called classificatory system. This conclusion is reached by a study of the character of two Siouan tribes, the Crow and Hidatsa.—F. R. **Moulton**: Solution of an infinite system of differential equations of the analytic type. If the number of mutually gravitating bodies in the universe is infinite, and if beyond a finite number of them their initial distances from one another increase with sufficient rapidity as the number of bodies increases, there is a rigorous, though limited, solution of the problem of infinitely many bodies.—L. J. **Cole** and N. F. **Kirkpatrick**: A seven years' study of inheritance in pigeons leads to the conclusion that the normal ratio of the sexes of pigeons hatched is 105 males to 100 females; that the number of unisexual broods exceeds the number of bisexual broods; that there is no tendency for first-laid eggs to hatch males and second-laid eggs to hatch females; that there is a correlation between the time of hatching the second egg and that of laying the first; that the birds continue to sit beyond the normal period of incubation if the eggs do not hatch.—Alice **Rohde**: Vividiffusion experiments on the ammonia of the circulating blood. The generation of ammonia in shed blood occurs in the non-diffusible constituents of the blood.—C. P. **Olivier**: 126 parabolic orbits of meteor streams. Although the most important feature of this investigation is the calculation of 126 parabolic orbits, the most interesting result is the final proof of the connection of the Halley's and η-Aquarid meteors. It is further concluded that radiants are not stationary.—C. **Schuchert**: The basal silurian formations of eastern North America. Medina, Cataract, and Brassfield are to be retained as names for independent marine faunas and formations.—B. M. **Davis**: A method of obtaining complete germination of seeds in Oenothera and of recording the residue of sterile seed-like structures. By sowing seeds upon pads of filter papers placed in Petri dishes and thoroughly soaked, and by keeping the culture at constant temperatures, rapid germination was obtained.—S. J. **Bates**: The osmotic pressure of the ions and of the undissociated molecules of salts in aqueous solution. The author shows how the partial osmotic pressures of the ions and of the unionised molecules can be calculated by thermodynamic principles from the freezing-points and conductance-ratios at a series of concentrations. The results show that in general the osmotic pressure of univalent ions is considerably smaller, and that that of the undissociated molecules is very much larger, than would be required by the osmotic-pressure law of perfect solutions.—T. **Lyman**: The extension of the spectrum beyond the Schumann region. The author has been able to reach the wave-length $\lambda600$, and finds seven or eight lines in the helium spectra between $\lambda900$ and $\lambda600$, some of the lines being fairly strong.—A. S. **King**: Unsymmetrical lines in tube-arc and spark spectra as an evidence of a displacing action in these sources. The observed effects seem to be harmonised by considering as a necessary condition the presence of electrified particles moving at high velocities, these being produced in the arc and spark by the strong potential-gradients, and in the tube-arc by the large consumption of energy.—H. **Blumberg**: The factorisation of various types of expressions. The methods of E. H. Moore's "General Analysis" are applied to giving a uniform central theory for factorisation of different series of expressions.—G. E. **Hale**: The direction of rotation of sun-spot vortices. Of the two spots in the typical spot-pair the preceding spot in the low-latitude zone is counter-clockwise north, and clock-wise south, of the equator; corresponding to the direction of the rotation of terrestrial tornados. In high latitudes the signs are reversed, giving a result which is likely to prove significant in future studies of the sun.—G. E. **Hale** and G. P. **Luckey**: Some vortex experiments bearing on the nature of sun-spots and flocculi. Some of the phenomena of single and multiple sun-spots can be imitated by simple laboratory experiments, in which vortices are formed in a water-tank with an atmosphere of smoke above the water. Such experiments may assist in accounting for certain characteristic structures and motions of the solar atmosphere.

NEW SOUTH WALES.

Linnean Society, March 31.—Mr. A. G. Hamilton, president, in the chair.—**Esben-Petersen**: Australian Neuroptera. Part ii. This contribution deals with the Australian species of Myrmeleonidæ, comprised in fourteen genera; but the material available was insufficient for working out two of the large genera, Myrmeleon and Formicaleon. One genus and eight species are proposed as new.—G. I. **Playfair**: The genus Trachelomonas (Infusoria: fam. Euglenidæ, Stein). The extra-Australian records of the genus amount to a total of twenty-five published species of greater or less validity, and eight variations. Australian waters are very rich in forms of the genus, exhibiting a great variety of type.—E. **Breakwell**: The anatomical structure of some xerophytic native grasses. Grasses of eleven species, all but one from the Nyngan district, were studied.

April 28.—Mr. A. G. Hamilton, president, in the chair.—H. J. **Carter**: Descriptions of six new species of Buprestidæ (Coleoptera). The species described are referable to the genera Chalcotænia, Buprestis, Bubastes (2 spp.), Neocuris, and Stigmodera; all, with the exception of one species of Buprestis from Dorrigo, N.S.W., from Cue, West Australia.—G. F. **Hill**: Northern-territory Termitidæ. Part i. This contribution to a knowledge of the Australian Termitidæ has been prepared from part of a large collection of Termites, and many field-notes compiled during the past two years, in what may be termed the coastal region of the Northern Territory. Fifteen species are dealt with in this paper, eight of which are described as new. With the exception of one species of Eutermes, which builds a very small mound, all the termites found in the Territory collect the great bulk of the earth and sand used in their termitaria, upon the surface.—T. **Steel**: The feeding-tracks of *Limax maximus*, Linn.

CAPE TOWN.

Royal Society of South Africa, May 19.—Dr. L. Péringuey, president, in the chair.—A. **Brown**: The equivalent mass of a spring vibrating longitudinally. The paper deals with the allowance to be made for the mass of a spring when a weight attached to it is oscillating under gravity and the tension of the spring. The fraction one-third of the spring's mass is correct for great added weights; for very small weights the fraction is a little over two-fifths. The variation of this fraction is considered theoretically, and data supplied to give its value for any weight. Experiments are described confirming the theoretical results.—A. W. **Rogers**: The occurrence of dinosaur bones in Bushmanland. Dinosaur bones were found in a well in Bushmanland at 112 ft. below the surface. The well is in an old valley cut in gneiss and filled in with local débris. It seems probable that the climate became dry while the dinosaurs lived there, and that since then the valley has been steadily filled up.—S. H. **Haughton**: Description of the dinosaur bones from Bushmanland. The bones discovered by Dr. Rogers consist of a maxillary tooth and portions of the hind limbs and caudal vertebra of a medium-sized Ornithopodous Dinosaur. They are described under the name Kangnasaurus Coetzeei n.g. et sp., which is shown to have affinities with Camptosaurus and its allies, and with Mochlodon and Hypsilophodon. The form is certainly younger than Camptosaurus, but no estimate of its exact age is given—the evidence being considered to be insufficient.—C. K. **Brain**: The Coccidæ of South Africa. The paper, which is the first contribution to a catalogue of the Coccidæ of South Africa, deals with five subfamilies, viz.:—Pseudococcinæ, Orthesiinæ, Coccinæ, Monophlebinæ, and Margarodinæ. Sixty-three species and two varieties are described, of which number thirty-two are here dealt with for the first time.—J. S. v. d. **Lingen**: A note on the molecules of liquid crystals. The object of the paper is to show the effect of bi-prisms on the Laue spots. Experiments carried out with prisms of NaCl show that the spots are "fluted," and that the central spot is elliptic instead of circular. 60° and 179° bi-prisms show this phenomenon, especially when they are rotated through a small angle.—J. S. v. d. **Lingen**: The "lines" within Röntgen interference photographs. The author holds that these lines are due to the ruptured surface, which will most probably resemble an echelon grating. Sodium chloride, quartz, silicon, and magnesium hydroxide photographs are described. These show "irregular spots" under certain conditions.

BOOKS RECEIVED.

Arithmetic. By C. Godfrey and E. A. Price. Parts i., ii., and iii. Complete. With Answers. Pp. xiii+467. (Cambridge: At the University Press.) 4s.

Typical Flies: a Photographic Atlas of Diptera, including Aphaniptera. By E. K. Pearce. Pp. xii+47. (Cambridge: At the University Press.) 5s. net.

Citizens To Be: a Social Study of Health, Wisdom, and Goodness. By M. L. V. Hughes. Pp. xvii+331.. (London: Constable and Co., Ltd.) 4s. 6d. net.

The Natural History of the State: an Introduction to Political Science. By Prof. H. J. Ford. Pp. viii+188. (Princeton, U.S.A.: University Press; London: Oxford University Press.) 4s. 6d. net.

Ship Form, Resistance and Screw Propulsion. By G. S. Baker. Pp. vii+245. (London: Constable and Co., Ltd.) 12s. 6d. net.

Plain and Reinforced Concrete Arches. By Prof. J. Melan. Translated by Prof. D. B. Steinman. Pp. x+161. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8s. 6d. net.

A History of British Mammals. By G. E. H. Barrett-Hamilton and M. A. C. Hinton. Part xvii. (London: Gurney and Jackson.) 2s. 6d. net.

Introduction to Heat. By A. R. Laws and Dr. G. W. Todd. Pp. x+212. (London: Mills and Boon.) 2s. 6d.

Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of s.y. *Scotia* during the Years 1902, 1903, and 1904, under the Leadership of Dr. W. S. Bruce. Vol. iv. Zoology. Parts ii.–xx. Vertebrates. Pp. xii+505+plates. (Edinburgh: The Scottish Oceanographical Laboratory.) 50s.

Plane Geometry. By G. St. L. Carson and Prof. D. E. Smith. Part i. Pp. vi+266. Part ii. Pp. vi+259–482. (London and Boston: Ginn and Co.) 2s. 6d. each part.

Elements of Algebra. By G. St. L. Carson and Prof. D. E. Smith. Part ii. Pp. v+325–538. (London and Boston: Ginn and Co.) 2s. 6d.

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THURSDAY, JULY 22, 1915.

FORESTRY AND TREES.

(1) *Studies of Trees.* By J. J. Levison. Pp. x + 253. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 7*s.* net.

(2) *Forest Valuation.* By Prof. H. H. Chapman. Pp. xvi + 310. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8*s.* 6*d.* net.

(3) *Chinese Forest Trees and Timber Supply.* By N. Shaw. Pp. 351. (London: T. Fisher Unwin, 1914.) Price 10*s.* 6*d.* net.

(1) THIS is an interesting book on the study of trees, specially suitable for use in the schools of Canada and the United States. Three chapters deal with the identification of the common North American trees, and of a few introduced European species, as the Austrian and Scots pines, Norway spruce, Alpine larch, horse-chestnut, Lombardy poplar, etc. Other chapters are devoted to the structure and habit of these trees, and their protection against animal and fungoid attacks. One chapter is taken up with elementary forestry, and another with the recognition and properties of the timbers in common use. The concluding chapter is an outdoor lesson on trees. The book is copiously illustrated; but, as is usual in publications of this class, the illustrations are of unequal value. The price, 7*s.*, will make it unavailable for use in schools in this country; but it deserves a place in town libraries. It is said to be obtainable in separate pamphlets, each dealing with one of the subjects treated.

The author describes in a concluding paragraph the Tree Clubs which have been founded in Brooklyn, Newark, and other eastern cities, with the object of interesting children in the care of trees. "The members of these clubs are each given the tree warden's badge of authority, and assigned to some special duty in the preservation of local trees. A plan of study and of outdoor trips is laid out for them by their director, and at stated periods they are given illustrated lectures on trees and taken to the neighbouring parks or woodlands." In happier times, we may also have tree wardens and tree clubs, which will render impossible such destruction as occurred two or three years ago in the felling of the beautiful relic of an ancient wood, the King's Hedges, near Cambridge, as soon as it had become the property of the county council.

(2) Forest valuation is concerned with the determination of the value of standing timber, of the land on which it grows, and of the forest as a whole, as well as with the rental produced. It compares also the financial results obtained in forestry with those yielded by other enterprises, and solves the merits of different methods of treatment of the forest. The importance of forest valuation cannot be gainsaid, as woods and plantations must be valued in all cases of sales, and whenever the property is assessed for taxation. Moreover, when schemes of afforestation are being considered by the State, by corporations, by companies, or by private owners, the only possible inducement for such undertakings must be based on the financial results that are reasonably to be expected. The correct appreciation of such results is by no means an easy matter. Forestry valuation deals with periods of time which are much longer than those that are ever considered in other financial considerations. Life insurance has an average risk of fourteen years, and earns about 4 per cent., obviously attracting much capital. Forests, in some cases, as coppice, bring in returns in ten to twenty years; but as a rule 40 to 120 years is the age of an ordinary plantation when felled. It is not yet agreed what rate of interest should be earned on the capital invested in forestry; and, in addition, correct and full data on which to base the calculations of the financial returns are not available in this country.

An extensive literature on the subject has been developed during the past seventy years by numerous German and French writers; but in England we have only had two serious writers—the late Dr. Nisbet and Sir W. Schlich. The latter, in his "Manual of Forestry," vol. iii., pp. 111 to 164, presents the gist of the matter in a condensed form, somewhat difficult to students who have not been previously trained, both in economics and in actuarial methods.

Prof. Chapman's book is fairly complete and has great merits. The subject proper is prefaced by four excellent chapters entitled "Values," "Outlay and Income," "Interest," and "Valuation of Assets," which will enable the student to understand the principles underlying the business of forest production. The succeeding chapters are highly technical, yet at the same time very practical, as befits a professor in an American university. He introduces, for example, a number of forms for use in forest book-keeping.

In the chapter on profits, Prof. Chapman discusses the question of private *versus* State ownership of forests; and considers it impossible for private forestry to be practised now on a large scale. He adduces conclusive reasons why the Government of the United States must continue to increase the extent of the national forests, and to take on itself more and more the production of timber. The book is replete with useful formulæ and tables, and can be recommended as the best text-book on forest valuation yet published in the English language.

(3) This book on the forest trees and timber supply of China undoubtedly contains some interesting pages. The author, a Chinese customs official lately stationed in Manchuria, gives a brief history of the forests and timber trade of this region, with a description of the modes of felling timber and rafting it on the Yalu and Sungari rivers. His slight sketches of the forest conditions of the other provinces occasionally give some information of value. It is sad to learn that the ancient hunting forest of the emperors, the Weichang in Chili, which Colonel Wingate estimated to be 400 square miles in extent in 1910, is now reduced to 100 square miles, owing to the ravages of the peasants since the revolution. Foochow and Hunan appear to be the most prolific of the provinces in timber supply; but great forests also exist in Szechwan, Kweichow, and Yunnan, which are as yet inaccessible. Until, however, a report is made by some competent forester, it is impossible to gauge the wealth of timber in the interior of China, as many of the forests reported by missionaries and travellers, while botanically marvellous owing to the variety of the shrubs, trees, and herbs, contain only a sparse supply of useful timber trees.

The volume is an uncritical compilation from various books, journals, and official reports, which are indicated in a bibliographical list. It is unfortunate that most important sources of correct information have not been consulted, such as Bretschneider's learned volumes, "European Botanical Discoveries in China" and "Botanicon Sinicum." The "Index Floræ Sinensis," an enumeration of all known Chinese plants, showing their exact distribution, which was issued by the Linnean Society, has not been used by Mr. Shaw, who scarcely appreciates the necessity for correct nomenclature. The *Kew Bulletin*, which in many volumes contains excellent notes and articles on Chinese trees and their peculiar products, is not quoted. Valuable papers on the Chinese names of trees and shrubs, which appeared some years ago in the journals of the Shanghai and Tokyo branches of the Royal Asiatic Society, have escaped notice.

The book has consequently no scientific value; and its numerous errors and omissions cannot be dealt with in a brief review. One may, however, give an instance. Mr. Norman Shaw prefaces a confused account in six pages of an important coniferous genus, with the statement that "the different species of pine in the Chinese region appear never to have been classified." Is he unaware that his namesake, Mr. G. R. Shaw, has fully described the Chinese pines in his great monograph, "Genus Pinus," and in vols. i. and iv. of "Plantæ Wilsonianæ"? The fascinating notes appended to the latter by Mr. E. H. Wilson would have provided our author with trustworthy readable matter, and saved him from such erroneous statements as that *Pinus maritima*, a Mediterranean species, is a native of China; and that *Pinus koraiensis*, a northern type not growing wild south of Korea, is met with in southern China.

The Chinese names of trees are not invariably given, and are often incorrect. Confusion of names apparently accounts for such errors as that the leaves of the Ailanthus (*Chou-chun*, p. 204) are used as a vegetable, the species thus employed being *Cedrela sinensis* (*Hsiang-chun*); and that the wood used for musical instruments is Sterculia (*Wu-tung*, p. 256), whereas it is *Paulownia tomentosa* (*Pao-tung*), a beautiful and common tree in China, not mentioned in this book. It is the pine-apple and not the screwpine (p. 307) which yields the fibre used in making fine cloth in Yunnan. Botanical errors are numerous, as the inclusion amongst Manchurian conifers of three species, *Larix leptolepis, Picea hondoensis*, and *Picea polita*, which are confined to Japan.

The section of the work, pp. 203–309, devoted to trees is inadequate and confused; and we advise readers interested to consult the books indicated by us above, and, in addition, Mr. E. H. Wilson's "Naturalist in Western China," which is replete with valuable and correct information about Chinese trees and their products.

Mr. Shaw's forestry is as unsatisfactory as his botany. We eagerly opened the book to learn something about the extensive afforestation carried on since 1899 in the German colony of Kiao-chao. This is dismissed in a short paragraph giving scarcely any information about the species employed and their success or failure. Tree planting at Weihaiwei and Hongkong, effected by the British Government, receives equally inadequate treatment. As the author mentions amongst his correspondents Prof. Baillie, of the Nanking University, one expected a full account of the interesting forestry work begun by the latter in Kiangsu. Mr. Shaw merely says (p. 81) that "credit is due to Prof. Baillie for his afforestation scheme on the hills near the old capital."

The Nanking professor's pioneer afforestation work, based on co-operation with the Chinese gentry, deserved description. Some details were published in the *National Review* (China) of April 25, 1914, the list of species employed being given, etc. The great difficulty of afforestation in China seems to be danger from fire, 200,000 trees, for example, having been burnt in the experimental plantation on Purple Mountain in 1913. Professor Baillie since then has established fire-lines, 30 to 100 ft. wide, which are let to Chinese farmers, who keep these lines cultivated and at the same time take care of the adjoining plantations.

The book is illustrated by thirty-three reproductions of photographs, some of which have appeared in well-known books of travel. Those taken from Major Osaki's "O Ryoko" represent well the methods of logging and rafting timber in Manchuria. Twelve photographs by Mr. Purdom, a recent plant collector in North China, are of unequal merit, that of the Chinese horse-chestnut being the best. There is also a good picture of *Pinus bungeana* at Peking, a tree often planted in temple grounds, the bark of which is of a milky-white colour, and peels off in patches like a plane, thus giving the stem an extraordinary appearance.

DYNAMOMETERS.

Dynamometers. By Rev. F. J. Jervis-Smith. Edited and Amplified by Prof. C. V. Boys. Pp. xvi+267. (London: Constable and Co., Ltd., 1915). Price 14*s*. net.

THE late Mr. Jervis-Smith, a vicar at Taunton until in 1886 he took charge of the Millard engineering laboratory at Oxford, was a very modest and ingenious enthusiast in the experimental study of natural science. He was particularly absorbed in the study of methods of measuring mechanical power. A dynamometer measures the product of force into velocity. The chemical balance illustrates the great accuracy with which we can measure force and there is also great accuracy possible in measuring speed, but the measurement of their product with accuracy is a very different thing. To measure the electrical power given out by or given to a machine is very easy; however large or small the power may be, our measurements may be made accurate to the fourth or even to the fifth significant figure. It is only in very exceptional cases that the measurement of mechanical power is correct to two significant figures.

Mr. Jervis-Smith left his MSS. in an incomplete form. The book is not a mere collection of lecture notes; many parts of it are quite finished, but on the whole it is rather disconnected. The author's sympathetic and admiring friend, Prof. C. V. Boys, has edited the book, and he has done this evidently as a labour of love. He has not attempted to make the book a complete treatise, but he has introduced between brackets interesting statements and amplifications which tend to make it a connected whole.

The author does not confine himself to dynamometers. He gives accounts of integrators, planimeters, and other contrivances which are related in one way or another to his main subject. We get the idea that this is a scrapbook in which he placed anything that interested him. There are places—as at the beginning, but elsewhere also—where he is evidently writing a book, but in other places we have evidence of scissors and paste. It seems to have been his intention not just to print these scraps, but to use them as a foundation for better descriptions of his own. We are glad to have them, as they would otherwise have to be searched for in many publications, and although some of them might have been omitted with advantage, we regret that they are not more numerous.

There are parts, as when he deals with friction and planimeters, where he gives a valuable, exhaustive list of references. If he had lived he would no doubt have done the same for other parts of the subject. Sometimes, as in the rope dynamometer brake (p. 71), the descriptions are not easily understood as no figure is shown, and indeed all the rope dynamometer part is rather weak. The descriptions of the water brake of Froude and other things are too long and yet simple explanations are wanting. A certain air brake is described in too much detail, and the account of the behaviour of a copper disc moving in a magnetic field is tedious. The account of Borda "On the Flow of Fluid from Orifices in Vessels" is quite out of place in this book. A short account of General Morin's work on friction would be better than a translation of the original paper. We feel sure that if the author had lived he would have made the whole book as perfect as part of it is, but we can understand why the editor may have been unwilling to discard or alter too readily some of the things we have mentioned. After all they are interesting. The book gives the most interesting and complete account of dynamometry that is known to us, and it owes a great deal of its interest to the additions made by the editor. In a few places we think that Prof. Boys is not quite fair. Mr. S. G. Brown did not merely employ a known principle as to friction in his famous submarine telegraph relay; he was the discoverer of the principle. The same may be said about the description of Brown's mechanical relay. We think that Prof. Boys is occasionally misled by assuming that his own very intimate knowledge of phenomena is shared by other people. J. P.

MATHEMATICAL TEXT-BOOKS.

(1) *Subjects for Mathematical Essays.* By Dr. C. Davison. Pp. x + 160. (London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

(2) *Junior Algebra.* By A. G. Cracknell and A. Barraclough. Pp. vi + 280. (London: University Tutorial Press, Ltd., 1915.) Price 2*s.* 6*d.*

(3) *Papers Set in the Qualifying Examination for the Mechanical Sciences Tripos,* 1906–1913. Pp. 90. (Cambridge: At the University Press, 1914.) Price 2*s.* net.

(4) *A Shilling Arithmetic.* By W. M. Baker and A. A. Bourne. Pp. xiv + 192. (London: G. Bell and Sons, Ltd., 1915.)

(5) *Practical Mathematics Second Year.* By A. E. Young. Pp. xi + 164. (London: G. Routledge and Sons, Ltd., 1915.) Price 2s. net.

(6) *The Laws of Algebra.* An Elementary Course in Algebraic Theory. By A. G. Cracknell. Pp. vi + 68. (London: University Tutorial Press, Ltd., 1915.) Price 1*s.*

(1) THIS collection of essays will be found of the greatest value in the training of mathematical scholarship candidates. Such work as this enables a student to coordinate his knowledge, and so consolidates the material that is floating vaguely about his mind, when he has completed the various courses of reading prescribed for him. It is indeed mainly by essay work that he begins to see the bearing of one subject on another and to appreciate the help which can be derived from the interfusion of subjects. We do not therefore recommend the use of this book merely because it will stand the candidate in good stead for examination purposes, but because we believe that the greater breadth of outlook essay work produces is of real educational value to him, and because it plays a part in his mental development which no other form of exercise can achieve.

(2) This course takes the reader as far as quadratic equations, and the two final chapters deal with indices and logarithms. In addition to illustrative examples, there is a considerable amount of explanatory matter. The former is essential, but it is open to question whether junior students can profitably read the discussions which text-books often contain: for example, on page 70 we find "Related Unknowns.—One of the chief uses of algebra is that of solving problems where it would be either difficult or impossible to solve them by arithmetic. The method is to represent the unknown quantities by letters, then to express the problem as an equation and to solve this equation." In our view, such passages as these merely overload the book and assist neither the pupil nor the teacher. There are no particularly original features, but the examples are well arranged and provide a sensible elementary course.

(3) The reprint in a cheap and compact form of papers set in the Mathematical and Engineering Triposes at Cambridge is of real service to a large circle of students. The general character of the papers is evidence of the recent changes in mathematical teaching. Those engaged in the higher work in secondary schools will find here much that will enrich their weekly problem papers. The questions are both practical and stimulating.

(4) This small volume includes all the arithmetic that in our view ordinary students require and some things, such as true discount or inverse compound interest, they should omit. If the general education is to include, as we believe it ought, trigonometry, practical mechanics and, if possible, the ideas of the calculus, it is essential that arithmetic should be merely a means to an end, a preparation for other work rather than a subject in itself. It is the comparatively slight dimensions of this text-book that constitute its chief claim to favourable consideration.

(5) The author has already published a course of practical mathematics for first year technical students: this volume contains the subject matter of the second year course. In this volume, as in the first, there is a first-rate set of examples, and we have no hesitation in recommending it for extensive use.

(6) This discussion of the meaning and validity of the fundamental laws of algebra is intended for senior divisions of secondary schools. It includes rational and irrational numbers, and rational indices, but excludes imaginaries, infinities, limits, and irrational indices. The language is throughout simple and the argument is set out clearly, but we are doubtful whether the author's partition is satisfactory. The theory of limits has now assumed so prominent a place in modern analysis that it is hard to refuse to admit it into the school curriculum, and it seems wise therefore to take it in conjunction with any substantial discussion of irrational numbers.

ELECTRICITY AND MAGNETISM.

(1) *Elementary Electricity and Magnetism.* By W. S. Franklin and B. Macnutt. Pp. viii + 174. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 1.25 dollars net.

(2) *Advanced Theory of Electricity and Magnetism.* By W. S. Franklin and B. Macnutt. Pp. vii + 300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 2.00 dollars net.

THESE books are written purely with a view to the practical application of electricity and magnetism. The choice of matter is excellent from this point of view, and it is all presented in a lucid, readable, and original manner, being illustrated with a large number of excellent diagrams. Experimental phenomena are usually described first, and to give students a grasp of their meaning mechanical analogies are given. Most of these analogies are excellent, but one gets the impression that on the whole too much attention is devoted to them, and that some of them could profitably be omitted. The introduction of the terms abampere, abvolt, and abohm for the absolute units of current, E.M.F., and resistance is a feature of the books. The electromagnetic system only is used, and in the advanced book the authors boldly declare that they are ignoring the electrostatic system altogether, a procedure that is perhaps wise, considering that the practical aspect of the subject predominates.

(1) The elementary book commences with a description of the most important phenomena in electricity from a practical point of view. Only the most elementary things in magnetism are described, and this part of the subject is of importance only in its relation to electricity. The action of electromagnets on wires carrying currents is described very early in the book, and the reverse phenomenon—the action of currents on magnets, which one is accustomed to find as a fundamental principle, does not appear till later. Great prominence is given to the "side push" on wires in a magnetic field (the term is the authors'), and, once described, its applications to the D'Arsonval galvanometer and to the dynamo follow. The tangent galvanometer is not described, as it is not a practical instrument. The "side push" is again employed in connection with magnetic intensity, which is defined as "the side force per abampere per unit length of wire." The chief practical things to which attention is given are the dynamo, motor, transformer, and induction coil.

(2) The advanced book is more of the usual type. The usual accounts of magnetic phenomena are given and the definitions here are normal. When electromagnetism is introduced a novel definition of unit of current—the abampere is given. This is defined as "the force per unit length of wire per unit field intensity." The meaning of the authors is clear, but their wording is unfortunate, as they define current as the "force." Whereas in the elementary book attention is devoted chiefly to the dyamo, etc., the advanced book seems to be written principally for telegraph engineers, as a very large amount of space is devoted to waves on wires. As an application of permanent magnetism, a chapter is devoted to ships' magnetism and the compensation of the compass. The chapters on electrostatics suffer from vagueness on account of the ignoring of the electrostatic system of units. For instance, the capacity of a parallel plate condenser is given as

$$C \text{ (in farads)} = 1/B \cdot a/x,$$

where "a" is the area of one plate in sq. cm., x the distance apart of the plates, and B is a constant $= 1 \cdot 131 \times 10^{13}$. However, again the practical aspect is kept in view, and space is devoted to such things as the design of insulators for cables and the capacity of a transmission line.

Both books will be found of great value to students to whom the practical side of electricity and magnetism is the all-important thing, and in fact they will also be profitable to others if read in conjunction with some of the more abstract treatises.

A large number of examples is given with each chapter.

J. R.

OUR BOOKSHELF.

Mechanism of Steam Engines. By Prof. W. H. James and M. W. Dole. Pp. viii + 170. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 8*s*. 6*d*. net.

THE purpose of the authors in producing this book has been to provide an elementary treatise on the kinematics of reciprocating steam engines and steam turbines, and to make clear to the beginner the mechanical principles on which a steam engine operates. Special attention is given to valve gears and governing devices; the underlying heat theory is not treated. The book opens with a general discussion of a reciprocating steam engine, followed by types of single-valve engines. The valve ellipse, together with the Zeuner, Reuleaux, and Bilgram valve diagrams are described, and some typical single-valve problems are worked out. Centrifugal-throttling, crank-shaft and other governing devices are included, also riding cut-off valves and their governing devices. The book closes with sections dealing with reversing gears, valve setting, and turbine valve mechanisms and governors.

The volume is noteworthy for the clearness of the drawings (mostly taken from working drawings), and for the lucidity of the text. It is difficult, however, to state what precisely would be its position in the engineering courses at colleges in this country. This is owing to the matter being almost wholly descriptive. Students of engineering learn best by doing, not by merely listening or reading. Numerous valve diagrams are given, but no student desires to copy these, and no definite exercises are given to be worked out by the student himself. As a minor matter, we may point out that it would have been an advantage if even one leading dimension had been inserted in the detail drawings. It is difficult for beginners to sort out which devices are suitable for large and which for small engines. The book, however, can be recommended to any student who wishes to improve his knowledge of the construction of valve and governor details.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Dr. J. J. Graham Brown and Dr. J. Ritchie. Vol. xviii. (Edinburgh: Oliver and Boyd, 1915.)

THE directors of every research institution have to face a peculiar difficulty connected with publication. In issuing an account of the various inquiries conducted in the laboratories under their charge two modes of publishing are open to them. They may issue a special report, or they may allow the workers in the laboratories to contribute their results to appropriate professional journals or proceedings of societies. A special report is expensive; it does not secure the ear of the scientific public so well as professional journals do. The laboratory of the Royal College of Physicians in Edinburgh has combined these two methods; it has collected the papers contributed to various journals by its workers during 1913–14, and issued them as the thirteenth volume of its Reports. In all there are thirty-two papers, every one of them representing a definite contribution to the basal subjects of medicine. Four papers give an account of the researches of Dr. J. P. McGowan into the nature of sarcocyst, associated with the disease of sheep known in Scotland as "Scrapie."

Four papers are devoted to human anatomy, Dr. J. S. Fraser's sections of the inner ear being of particular merit. The remaining papers are devoted to biological chemistry, pathology, and bacteriology. We note particularly the research carried out by the late Dr. Alexander Bruce—whose death was a serious loss to British neurology—and Dr. James W. Dawson on a curious form of tumour which occurs in the central nervous system. A study of the minute structure of these neuromata supports the multicellular theory of nerve-fibres. Dr. D. P. B. Wilkie's important observations on the clinical signs of acute obstruction of the appendix vermiformis as distinguished from acute inflammation of the appendix also appears in this volume of reports. The thirteenth volume is one on which its editors, Dr. J. J. Graham Brown and Dr. James Ritchie, superintendent of the laboratory, may be warmly congratulated.

The Poison War. By A. A. Roberts. Pp. 144. (London: W. Heinemann, 1915.) Price 5s. net.

MR. A. A. ROBERTS, who is described as a member of the Chemical Society of France and also of the Society of Chemical Industry, has given the public a book to which no one with any chemical knowledge will deny the epithet "remarkable." Two or three short extracts from its pages will perhaps best illustrate its value.

On page 57 we find "The white smoke referred to, upon the explosion of German shells, is caused by the union of phosphoric and phosphorus acids with the oxygen of the air." On page 90 we are told: "Toluene is a colourless liquid obtained from resins such as tolu: the latter being the product of a South American tree. Some of the medicinal preparations of this resin are well known to the public, as 'Balsam of Tolu' and 'Friars Balsam.'" In reference to gun-cotton, on page 91 we learn: "Reverting to the subject of gun-cotton, this explosive is now made by soaking cotton or waste in nitric acid. Cotton is indispensable, as it absorbs the oxygen and nitrogen contained in the acid, and is a combustible substance." On page 98 we read: "Nitro-glycerine, or even gun-cotton, if burnt in an open vessel, will not explode, but the moment they are fired by detonation explosion follows, the explosion being due to decomposition." The non-poisonous character of nitro-glycerine is illustrated by the following statement on page 99: "A laboratory employé, in another instance, partook of two ounces of nitro-glycerine, mistaking it for chocolate, and on the morrow was none the worse for his stupidity."

Indian Mathematics. By G. R. Kaye. Pp. 73. (Calcutta and Simla: Thacker, Spink and Co., 1915.)

MR. G. R. KAYE's booklet gives a summary of the actual contents of Indian mathematical works, translations of original passages, an approximate chronology, and a bibliography. The net result of recent work in this field is to reduce still more the claims once made on behalf of Indian mathematicians, both in respect of priority and in that of originality; two main questions are still unanswered—who invented the decimal notation now current, and what is the complete history of the Pellian equation? Mr. Kaye suggests that India is probably indebted to China for some of its analysis, just as it is certainly to Greece for its geometry (in Arabic translations or otherwise); it is to be hoped that Chinese documents will be forthcoming to throw light on these and other matters. Meanwhile, such a work as this of Mr. Kaye's is very useful as a trustworthy conspectus of what is actually known about early Indian mathematics at present.

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 Structure of Magnetite and the Spinels.

THE structure of the spinel group of crystals is very interesting. These crystals are cubic, and possess the greatest possible number of symmetries. The composition is given by the formula, $R''R'''_2O_4$, where the divalent metal R'' may be Mg, Fe, Zn, or Mn, and the trivalent metal R''' may be Fe, Mn, Cr, or Al. Magnetite is $FeFe_2O_4$.

The structure is fundamentally the same as that of the diamond. Each carbon atom of the diamond is to be replaced by the divalent metal atom; the distance between two neighbours being 3·60 A.U. in magnetite as against 1·53 A.U. in diamond. The four oxygen atoms are arranged in a regular tetrahedron about the divalent atom. The lines joining the latter to the former are parallel to the four cube diagonals. Any two neighbouring tetrahedra point towards each other. If each perpendicular from a tetrahedron corner on the opposite face is produced it encounters another tetrahedron, passing first through the middle point of a face and then through the opposite corner. A trivalent atom lies on each such connecting line, half-way between the tetrahedra. The distance between a divalent and the nearest trivalent atom is 7·20 A.U. Four trivalent atoms are associated with each tetrahedron, but each atom is shared by two tetrahedra. As in other cases already examined, the molecule has no separate existence. The size of the tetrahedron may not be the same in all members of the group of crystals. The divalent atom lies at the centre of a tetrahedron of oxygen atoms, and the trivalent at the centre of an octahedron.

W. H. BRAGG.

Leeds, July 12.

The Magnetic Storm of June 17, and Aurora.

PROF. BARNARD'S interesting letter dated June 25, in NATURE of July 15, on what is termed "The Great Aurora of June 16, 1915," is at first sight rather puzzling to the non-astronomical reader. The large magnetic storm began about 1.50 a.m. on June 17. On June 16, it is true, there was a magnetic disturbance, but not such as to suggest a striking auroral display. The explanation presumably is that Prof. Barnard is referring to an astronomical day, commencing at Greenwich noon on June 16. This, at least, would explain his statement that at Wisconsin (about 90° W.) at 21h. 25m. "the sky was bright with dawn." This one would expect between 3 and 4 a.m. local time. If this is correct, then the first auroral appearance chronicled by Prof. Barnard was at 3.30 a.m. on June 17, Greenwich civil time, and the maximum brilliancy about 8.15 a.m. It was principally during these morning hours that the Kew magnetic curves had the rapid oscillatory character usually associated with aurora and earth currents. The newspaper reports quoted by Prof. Barnard seem to fit this explanation.

Passing to the Rev. A. L. Cortie's letter (p. 537), it really emphasises the difficulty of deciding whether individual sun-spots and magnetic storms are connected. There are often a number of spots visible at one time. A spot remains visible for a number of days, during which there may be several magnetic storms. If spots cause storms, the rule one spot one storm may not be observed. If I selected any given date, storm or no storm, the chances are Father Cortie could supply a spot. I think Father Cortie has not quite grasped my argument that quiet days show the twenty-seven-day period equally with disturbed days, and that one can scarcely associate them with limited areas or "anti-spots." If one associates them, as he now seems to do, with an undisturbed state of a whole solar hemisphere, why not equally associate storms with a generally disturbed state of a whole hemisphere? As a matter of fact, the average quiet day seems associated with a practically average state of solar spottedness. The 600 quiet days selected by the Astronomer Royal from 1890 to 1900 gave for Wolfer's provisional sun-spot frequency a mean value of 41·28, the mean from all days of the eleven years being 41·22. They showed the twenty-seven-day period very clearly.

C. CHREE.

Richmond, Surrey, July 17.

Surface Tension and Ferment Action.

IN NATURE of June 17 Messrs. E. F. and H. E. Armstrong criticise the conclusions drawn by Mr. Beard and myself in a paper published in the Proc. Roy. Soc. of June 1, under the title "Surface Tension and Ferment Action." We drew the conclusion that the action of invertase was inhibited by surface tension. According to Messrs. Armstrong the inhibition observed under the conditions of our experiments was due simply to a minute trace of alkali given off by the glass. They state in confirmation of their view that the action of the alkali given off by ordinary glass is so marked that it is impossible to obtain consistent results with invertase, unless hard glass vessels, test-tubes, and storage bottles are used. That is certainly not our experience. We failed to find any difference in the readings between two mixtures of cane-sugar and invertase, of which one was kept in contact with glass beads at medium temperatures, as long as the amount of invertase used was relatively large. Our experience in that respect is apparently in accordance with that of Sörensen, who states that the effect of the alkalinity of glass makes itself felt only in the case of invertase solutions which have been especially purified.

In our experiments an inhibition was noticed only when the amount of invertase was relatively small. Under these conditions an alteration in the hydrogen-ion concentration produced by the minute trace of alkali given off by glass may have had some share in producing an inhibition, but it does not account for certain features of the phenomenon, which we have been careful to emphasise in our paper. If the alkali from the glass was entirely responsible for the effect one would expect the inhibition to persist in its entirety after the glass beads have been removed. This was found not to be the case. Again, the weakening of an invertase solution, which had been allowed to stand in contact with glass beads at medium temperatures and which we ascribed to absorption of the ferment by glass, cannot be explained on the ground put forward by Messrs. Armstrong. Their view necessitates the assumption of so large an amount of alkali given off by glass to an invertase solution, that it should be detectable by such an indicator as phenolphthalein. This again was not the case.

The interruption of my work has unfortunately delayed the completion and publication of similar observations with diastase carried out by Mr. McCall and myself. It was found that the inhibition produced by extending the surface-glass water could be almost completely removed by coating the glass with a thin film of a surface-active substance, such as methyl alcohol, ethyl alcohol, amyl alcohol, ether. On the other hand, films of ligroin and xylol deposited on the glass failed to remove the inhibition.

Such facts, while not explicable on the ground that the inhibition is due merely to a trace of alkali derived from the glass, form a confirmation of the theoretical considerations put forward in our paper.

July 7. W. Cramer.

Origin of a Mathematical Symbol for Variation.

As a contribution to the history of algebraic notation it may be worth while to point out that the symbol $\propto$ for variation was introduced by William Emerson. In his "Doctrine of Fluxions," third edition, London, 1768 (first edition, 1749), he says on p. 4:—"To the common Algebraic Characters already receiv'd I add this $\propto$, which signifies a general Proportion; thus, $A \propto \frac{BC}{D}$, signifies that A is in a constant Ratio to $\frac{BC}{D}$; that is (if a, b, c, d be other Values of these Quantities) $A : \frac{BC}{D} :: a : \frac{bc}{d}$; and thus every general Proportion is to be understood." Florian Cajori.

1 Gordon Street, Gordon Square, London, W.C.

SCIENCE AND MUNITIONS OF WAR.

We give in another column the names of the members of the Inventions Board which is assisting the Admiralty in the co-ordination and encouragement of scientific effort in relation to the requirements of the Naval Service. The Central Committee and the Panel of Consultants form as strong a body of expert opinion as it would be possible to bring together; and their judgment upon scientific matters submitted to them may be accepted with confidence. Suggestions and inventions sent to the Admiralty will, if they relate to naval matters, first be considered by officials of the existing staff, and any promising ideas or devices will be passed on to the Central Committee, consisting of Lord Fisher, Sir J. J. Thomson, Sir C. A. Parsons, and Dr. G. T. Beilby. This committee, when necessary or desirable, will refer particular points to members of the panel of consultants, which includes leading workers in chemistry, physics, metallurgy, and various branches of engineering science. The president of the Royal Society is one of the consultants, and with one exception all the other advisers are fellows of the society, which is thus giving of its best to the service of the country.

Since the early days of the war the Royal Society has been in close touch with the naval and military authorities with regard to scientific problems presenting themselves in the course of the operations. In the autumn the Council set up an organisation which has been expanded in various directions to meet the continually increasing requirements of the Government for scientific assistance. It consisted essentially of a general controlling committee, which was at first appointed *ad hoc*, but is now the Council itself; and sectional committees, each of which represents one of the several branches of science concerned, namely chemistry, engineering, physics, and physiology. Each committee has been placed by the council in charge of a chairman of acknowledged eminence. The Governmental departments concerned have nominated special representatives who sit as members of the sectional committees, and through them and the committees' own officers confidential relations have been established with those departments. The committees also are in touch with the scientific institutions and manufacturing centres throughout the country. These committees as working bodies are necessarily limited in size, having regard to the very confidential nature of the subjects submitted to them; but they avail themselves largely, as circumstances require, of the services of investigators outside their own membership.

The value of the work thus accomplished was publicly recognised by the Prime Minister lately in his remarks in the House of Commons. But though the Government has acknowledged that scientific men have rendered valuable assistance in connection with problems arising out of the war, no definite scheme seems yet to exist for the organisation of our scientific forces into a composite body. The Chemical Society, as we announced on July 8, has taken steps of its own accord to form a consultative council upon which kindred societies such as the Institute of Chemistry, the Society of Chemical Industry, the Society of Public Analysts, the Pharmaceutical Society, and the Institution of Mining and Metallurgy will be represented. Scientific and industrial knowledge and interests are thus intimately associated, as they should be, but the relation of this group of chemical societies to the Physical Society, which has also formed a committee to consider suggestions and inventions, or to the war committees of the Royal Society, does not appear to have been settled. Unless there is close co-operation between the committees of the various scientific societies it is difficult to see how overlapping will be prevented or how combined expert knowledge can be concentrated upon physical, chemical, and engineering problems requiring early and practical solution.

In addition to appointing committees to consider suggestions or inventions, the Royal, Chemical, and Physical Societies have taken steps to obtain registers of their fellows classified according to special knowledge and to scientific services which the fellows are willing, as well as specially qualified, to perform. The idea in each case is to secure co-operation among the fellows of the particular societies, and to examine by means of committees any promising suggestions relating to munitions of war or kindred subjects. No one knows precisely what will be done with the registers when they have been completed. Each society seems to be compiling its list independently and without any clear view of the use which will be made of the experts' services which will become available by the response to its circular. No scheme has yet been put forward by which definite national duties will be assigned to the hundreds of scientific men who are enrolling themselves on the registers of their respective societies.

The case is different with men who are

capable of taking their places in workshops. A register of the names and addresses of all persons who are willing to devote either the whole or some definite part of their time to industrial service of the kind indicated is being made at many engineering laboratories, so that no one with any mechanical aptitude need now lament absence of opportunity of employment in national work.

In a number of engineering laboratories of universities and technical colleges in different parts of the country, short courses are now being conducted by means of which, for a nominal fee, preliminary training can be obtained which will enable suitable persons to be recommended by the Local Munitions Committees for employment in the manufacture of munitions of war. Practical experience of employers has shown that comparatively unskilled assistance may materially increase the output of munitions in a district. Of course, persons who have already had some experience in engineering workshops can render more effective service than those who lack such experience; but there is much work to be done on machines which are so arranged that unskilled men—or women—can use them after very little preliminary training. The classes arranged in engineering laboratories will provide the necessary instruction to enable these persons to perform useful national work.

The laboratories of our universities, university colleges, and technical institutions are at the disposal of the Government, and in many of them men are devoting twelve hours a day to work in connection with the supply of munitions of war. A few days ago the members of the Royal Institution decided to offer the resources of their laboratories and of the Davy Faraday Research Laboratory to the Government for the prosecution of any particular research by officers of the Admiralty, War Office, or Ministry of Munitions; and the managers invited communication from these departments "in case there is any field of research in relation to or connected with chemical and physical science, or either of them, to which the professors, assistants, and staff of the Royal Institution or of the laboratory can usefully direct their attention with the view of giving assistance to his Majesty's Government in the conduct of the war."

We notice that this resolution was sent to the First Lord of the Admiralty, the Minister of War, the Minister of Munitions, and the chairman of the Inventions Board of the Admiralty, but we can scarcely suppose that each of these officers of State will act independently in making whatever use is possible of the offer. Mr. Lloyd George has announced in the House of Commons that he has made arrangements with the Secretary of State for War to take over the invention work relating to the munitions of war for the supply of which his department is responsible. He has also arranged with the First Lord of the Admiralty to take over the work relating to new expedients and inventions for purely Army purposes which are at present in charge of that department.

This action is in the direction of the establishment of the proposed central committee or bureau to direct scientific and inventive energy into channels of effective work. In his recent address to the British Science Guild, Sir William Ramsay described Lord Sydenham's scheme for the constitution by the Royal Society of a general advisory committee to which all Departments of State would be directed to apply for assistance in problems requiring scientific treatment and investigation. The Royal Society is already in close association with the Government departments, and has instituted helpful work on many problems relating to the war, but there seems to be a need for common action between it and other scientific societies, both as regards the preparation of a joint register and the co-ordination of consultative committees. When such an organisation has been established, it should not be in separate connection with the Admiralty, War Office, Ministry of Munitions, and Board of Trade, but with a bureau to which scientific suggestions or inventions would be addressed, with the sure and certain knowledge that they would be submitted to expert trial and judgment. It is not yet clear whether Lord Fisher's Board is to be this central body or whether further committees are to be established by other Government departments concerned with scientific problems of the war and munitions. Good organisation demands concentration of effort upon common problems; and that end will not be reached by separate departments and separate scientific societies appointing their own committees and panels of consultants for independent work and advice. Co-ordination might be attained by the constitution of a grand committee on which each department and each scientific society concerning itself with national work would be represented, or a sort of official exchange might be established to which all suggestions or needs would be communicated, either to be dealt with by a small scientific staff attached to it or distributed to expert advisers for judgment. Only by linking up the various departments with one another and with scientific societies somewhat in this fashion can overlapping be avoided and the fullest advantage be secured most expeditiously from the services which men of science are prepared to place at the country's disposal.

Most people assume that these services will be voluntary; and a correspondent directs our attention to the fact that in the forms circulated by the Physical Society in connection with the proposed "War Register," it is stated that: "It is to be understood that all service would be voluntary, and unpaid, being given for the good of the country during this period of emergency." He adds: "I should like to inquire how it comes about that the Physical Society is not in a position to offer remuneration for work of the character specified in the circular on a scale at least bearing a reasonable proportion to the wages paid by the Government for the performance of less responsible labour. Is it really for the good of the country that this work should be unpaid?"

Government departments and statesmen find their requests for expert advice and guidance responded to so willingly by scientific men and societies that they overlook the necessity of making any recompense for work done. In the medical services every qualified practitioner receives rank and reasonable pay, while consultants are given generous retaining fees. In legal circles also no advice is expected without a retainer is attached to it; and in this connection we are interested in the announcement that "according to a statement made in the House of Commons Sir John Simon, as Attorney-General, drew 18,000*l.* as his remuneration for the past year." It should be unnecessary to urge that the laws of nature are of as much importance as the laws of the land, and that as in the present crisis men of science can be of greater service to the nation than lawyers or politicians, they should receive at least sufficient reward for it to enable them to put aside their daily work in order to take up national duties. There will be no lack of volunteer workers among scientific men, but the State should understand that its responsibility for payment on account of expert opinion is at least as great in the case of science as it is in law, medicine, and engineering.

THE EVOLUTION OF THE GONIOMETER.

THE goniometer—as the instrument used for the measurement of the interfacial angles of crystals is called—has gradually developed from a simple and crude piece of apparatus to a refined and somewhat complex optical instrument, and the measurements made with it have become increasingly more accurate as the form improved, while on the other hand the methods of investigating the morphological characters of crystals have on the whole become simpler. Nicolaus Steno, who (in 1669) was the first to study the angles between the plane surfaces of crystals, laboriously determined them by slicing the crystals perpendicular to the edges bounding the faces in question, and outlining the sections on paper. The first instrument used for the purpose of measuring the interfacial angles is that known as the contact-goniometer, and was devised by Carangeot in 1783; it is used to this day for measuring large rough crystals. This type consists essentially of two arms, one movable with respect to the other, which are laid on the faces in question at right angles to their common edge; the position on a graduated scale of the end of the movable arm beyond the pivot gives the angle required. A cheap form of this type made in cardboard or celluloid was designed by S. L. Penfield in 1900. Accuracy to single degrees of arc is the utmost that can under the most favourable conditions be expected of the contact-goniometer.

To the ingenuity of W. H. Wollaston, in 1809, is due the reflective form of goniometer. In this type the common edge of the pair of faces under measurement is set in line with the axis of a rotatable graduated circle, and the position of the circle is read when some distant signal is reflected by the particular face in a predetermined direction; the circle is rotated, and the reading taken corresponding to the second face. The difference between the pair of readings gives the interfacial angle required. In the original form the graduated circle was vertical, and no means existed for fixing accurately the direction of reference. In a goniometer described shortly afterwards, in 1810, by E. L. Malus, a telescope of low power was used for receiving the reflections, and assuring, therefore, the constancy of the direction of reference, and in 1839 J. Babinet designed an instrument with a horizontal circle. E. Mitscherlich introduced many improvements and accessories in 1843; he added a collimator in place of a distant signal, and his screw arrangements for centring and adjusting the crystal are in principle the same as those generally used now. The horizontal-circle form of goniometer is extensively used at the present day, and the optical features and accessories have been brought to a high standard of perfection by the well-known firm of R. Fuess, of Berlin, who have devoted considerable attention to crystallographical instruments. Spider-lines were first used in the collimator, and afterwards the ordinary spectroscope-slit, but neither are satisfactory for goniometer work owing to the diffusion of the image on reflection at the tiny faces such as often occur on crystals. The difficulty was investigated by C. F. M. Websky, and in 1878 he described a slit, the jaws of which consisted of coplanar circular discs in contact, or nearly so, at the middle. This slit allows plenty of light to pass at the top and bottom, and the constriction at the centre admits of refined readings. In its original form, or slightly modified, this slit is universally used in modern goniometers. For the purpose of viewing the crystal while in position and determining what face gives a particular reflection, the telescope is usually supplied with a lens which is applied in front of either the objective or the eyepiece for converting it into a microscope of low power. In a well-made instrument, if the crystal reflections admit, readings may be made to 30 minutes of arc.

Various modifications of this type have from time to time been devised. In 1903 H. A. Miers used an inverted form, that is one in which the crystal is suspended below the graduated circle, for making observations on crystals growing in their mother liquor. He also designed a stage goniometer for the measurement of the optic axial angle of small crystal flakes under the microscope. More recently, in 1911, Dr. A. Hutchinson designed a convenient form of inverted goniometer for the study and measurement of tiny crystals or crystal fragments. In the universal goniometer (Fig. 1), as he terms it, the telescope A and collimator C are placed at some convenient angle to one another, and a microscope B is so arranged that its axis bisects the angle between them. The instrument may be used in the ordinary way as a goniometer, as an axial-angle apparatus (a fitting carrying nicol and condensing lens being placed for the purpose opposite the microscope), as a total-reflectometer of the Kohlrausch type (the crystal being immersed in a specially made tank containing a highly refractive liquid), and as a refractometer by the prism method (the telescope being removed and attached to the graduated circle, and the crystal-holder transferred to the rod used for bearing the tank-table).

It is obvious that in the case of a goniometer with a single circle only one zone of a crystal can be measured at a time. The difficulty of measuring with such an instrument a small, many-faced crystal is consequently very great, and there is grave risk of mistakes being made owing to tiny faces of similar appearance being confused. W. H. Miller, when measuring a complex crystal aggregate in 1874, was the first to recognise the advantage of defining the position of each face on a crystal by a pair of angular co-ordinates analogous to the latitude and longitude of a place on the earth's surface—in the case of a crystal it is, however, more convenient to make the pole the origin of measurements—and thus avoiding the necessity of altering the adjustment of the crystal, at least during the measurement of one half of it. In this method a goniometer with two circles mutually at right angles is required. Miller merely clamped one goniometer with a vertical circle on to another with a horizontal circle; a brief description of the instrument was given in a posthumous paper (published in 1882 by his successor, Prof. W. J. Lewis, F.R.S.), but attracted little attention. Instruments on similar principles were designed by E. S. Fedorov in 1889, and V. Goldschmidt in 1893. A different pattern, in which the optical parts are movable about a horizontal axis, was designed by S. Czapski in 1893. F. Stöber in 1898 described a simple piece of apparatus consisting of a graduated circle, to which a crystal-holder was attached radially, for replacing the ordinary crystal-holder of the one-circle goniometer. This attachment has the inconvenience that in any position of the telescope the reflections from certain diametrically opposite parts of the crystal are obscured, and it is necessary to move the telescope through a measured angle; moreover, since the circle moves in so large a collar, accurate readings cannot be expected.

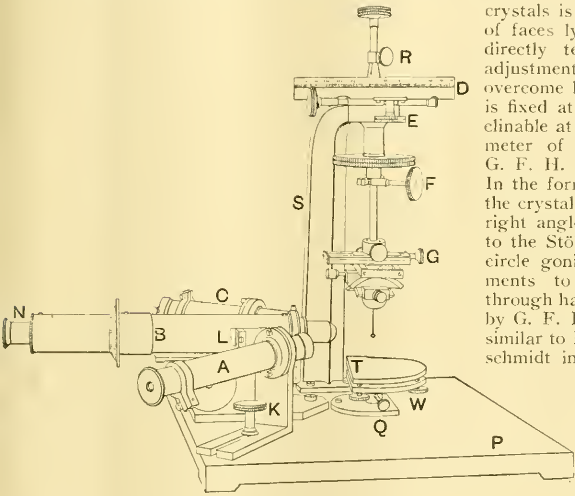

FIG. 1.—Hutchinson's Universal Goniometer.

In the measurement of a crystal with a two-circle goniometer, if, as happens in the triclinic and sometimes in the monoclinic systems, a face of symmetry is not crystallographically possible at right angles to the edge of the zone of symmetry by which the crystal is adjusted, measurements are not made in zones, and consequently the most important property characterising crystals is not utilised. In any case the zonality of faces lying in or near cross zones cannot be directly tested on the instrument without re-adjustment of the crystal. The difficulty may be overcome by the addition of a third circle, which is fixed at right angles to the second, and is inclinable at any angle to the first circle. A goniometer of this type was described in 1899 by G. F. H. Smith, and in 1900 by J. F. C. Klein. In the form designed by E. S. Fedorov, in 1900, the crystal has two motions about axes mutually at right angles in large semi-circular collars similar to the Stöber circle already mentioned. A three-circle goniometer with modified optical arrangements to allow of continuous measurements through half a revolution in any zone was designed by G. F. H. Smith in 1904. An instrument very similar to Fedorov's was described by V. M. Goldschmidt in 1912.

CHEMICAL FIRE-EXTINGUISHERS.

THE article on "The Extincteur and its Limitations" in NATURE of June 3 described some practical points relating to the construction, tests, and use of portable fire-extinguishers now widely advertised and purchased. So much attention has been given to the article that a supplementary account of the chemistry of such extinguishers should be of equal interest and service. In putting out fire the chief things to be aimed at are the reduction of temperature and the exclusion of oxygen. Either will suffice if it can be obtained in a great enough degree, for combustion will not proceed if the temperature of the burning substance is lowered beyond a certain point; nor—apart from special cases with which we are not now concerned—can it take place in the absence of oxygen. In one class of the special preparations devised for use as fire-extinguishers the two effects are usually combined; in another class the second effect is chiefly the means relied upon to secure extinction of the fire.

Water charged with carbon dioxide is the commonest example of the first class. The water cools down the burning mass, and itself becomes heated in the process, whilst the carbon dioxide expelled from the water by the heat displaces the atmospheric oxygen in the immediate neighbourhood, and both causes combine to stop the combustion. The larger extinguishers such as are usually supplied to public buildings are of this kind. They contain, typically, a strong solution of sodium carbonate and a charge of hydrochloric or sulphuric acid. The acid is kept separated from the carbonate until the apparatus is wanted for use, when by means of a breaking or overturning device the acid is mixed with the solution, and immediately liberates the carbon dioxide. The pressure of the gas forces the solution out of the apparatus, just as in the action of an ordinary "syphon" of soda-water.

Other aqueous solutions, frequently used in small extinguishers of the hand grenade type, contain chlorides instead of carbon dioxide. Apart from the water, these are considered to act as fire-quenchers partly by producing extinctive gases, and partly by coating the burning material with a non-combustible film. One formula for such a grenade, for instance, contains common salt and sal-ammoniac, another includes calcium and sodium chlorides, others contain chlorides of calcium and magnesium. Of similar type, too, are some preparations containing sulphites. Thus a solution of sodium sulphite and sal-ammoniac acts as a fire-extinguisher partly by giving off ammonia and sulphur dioxide, partly by the cooling effect of the water, and partly by coating the burning material with sodium chloride.

Of these small extinguishers it may be said in general that for quenching incipient small fires indoors they are useful, but too much should not be expected of them. The quantity of solution in a single extinguisher, or in half a dozen, is too small to be effective unless the fire is of quite restricted dimensions. Much of the quenching effect, it must be borne in mind, is due to the water; and though the chemicals enhance this effect, they do not multiply it to an unlimited degree.

For use more particularly in putting out fires of burning liquids such as petrol, kerosene, and other mineral and vegetable oils, which float upon the surface of water and so may be spread by the latter, extinguishers containing dry powders are sold, and also others composed of non-aqueous liquids. The powders generally include carbonates or bicarbonates, with or without an admixture of chlorides. One much advertised article, for example, consists of a mixture of calcium carbonate and sodium bicarbonate. Their action depends chiefly upon the evolution of carbon dioxide and other gases, under the influence of heat. Like the hand grenade class, these extinguishers are in general effective only with small fires, and not in all circumstances. For example, a film of burning liquid might be extinguished readily by a covering of one of these powders, whereas the powder thrown on a thick layer of the liquid might fall to the bottom and remain practically unaffected, at least until the oil had burnt down to its level.

Of the non-aqueous liquids employed the chief appear to be chlorinated hydrocarbons. They are probably mixtures of several members, but approximate more or less closely to tetrachloroethane, or to mixtures of this with carbon tetrachloride. These depend for their effect upon the production of extinctive gases when heated, and one disadvantage of their employment is the evolution of fumes, copious and unpleasant, consisting of hydrogen chloride. For use on small petrol fires, and also on small quantities of ignited inflammable materials, such as celluloid and carbon bisulphide, they appear to be reasonably efficacious. For larger fires, especially of loose combustible substances such as straw, paper, shavings, and the like, they are of much less value. Extinguishers of this class have thus a special and limited usefulness rather than general applicability to ordinary conflagrations. In fact with these as with all extinguishers, it is well to remember that whilst the prompt application to a small incipient fire may be effective, it is quite another matter when a big blaze has been allowed to develop.

THE SURGERY OF THE WAR.

WE are familiar, by this time, with the saying that the War has brought "Listerism" back for the treatment of our wounded. Not that the use of antiseptics had ever vanished out of practice: but the aseptic method—the sterilising, by heat, of almost every appliance of surgery—had come into general use, and had been reckoned as a great improvement on the antiseptic method. It had seemed a safer, more natural, more scientific way of operating. And in civil practice it is, indeed, well-nigh perfect. It is "the ideal method." That is to say, it would be perfect if all surgeons, nurses, and patients were perfect. But it is not so simple as it sounds: and some surgeons, perhaps, have so admired the pursuit of the ideal that they have been tempted to think of Lister's work as a mere "stage" on the way to their own. Then came the War; and, at once, surgeons had to face a condition of wounds very different from the clean-cut incisions made in the formal operations at placid, well-appointed hospitals and nursing-homes over here. This overwhelming multitude of shell-wounds and shrapnel-wounds, infected right away with mud and sweat and particles of clothing, and with all the germs of heavily manured soil, must be disinfected, if that were possible, with antiseptics. Thus, there has been that return to the antiseptic method which Sir Rickman Godlee described, a few months ago, in his lecture at the Royal Institution.

But this return to Listerism reminds us of Mme. de Staël's wise saying, "L'esprit humain fait progrès toujours, mais c'est progrès en spirale." If we are indeed back at Lister, we are back at a higher level. It is exactly half-a-century since he, in Glasgow, in 1865, first plugged the wound of a compound fracture with a strip of linen soaked in coarse, impure, undiluted carbolic acid. What came of that experiment the world knows, and is not yet tired of knowing. But he could not then foresee the wealth of new discoveries which followed, incessantly, this first method of dealing with "germs of putrefaction." Least of all could he foresee the swift rise of bacteriology, its extension over the whole art and science of medicine and surgery, and its magnificent achievement of protective treatments, antitoxins, and vaccines. But he lived to see them, and to help to make them possible. We are likely to have in our hands, before many months, the final and authoritative record of his life and of his work. It will be a book worth waiting for, and it will be, even in these hard times, a book worth buying.

Meanwhile, for all who love to read of surgery—and who does not?—there are two admirable lectures by Keen of Philadelphia, entitled "Before and After Lister." They were given to the United States Army Medical School a few weeks ago, and are published in *Science*, June 11 and 18. They have much to say of military surgery, past and present, and they say it very well. There is also a very striking article in the *Times* of June 28, on "Wounds and Blood-poisoning," and on the present work of Sir Almroth Wright at Boulogne. The lectures and the article, between them, give us a good insight into the *progrès en spirale* of surgery, from 1865 to 1915.

NOTES.

It was announced on July 5 that Admiral of the Fleet Lord Fisher of Kilverstone had been appointed chairman of the Inventions Board established to assist the Admiralty in co-ordinating and encouraging scientific effort in relation to the requirements of the Naval Service. The arrangements for the organisation of the Board have now been completed. It will comprise:—(*a*) A Central Committee; (*b*) a Panel of Consultants composed of scientific experts who will advise the main Committee on questions referred to them. The Central Committee will consist of:—Lord Fisher of Kilverstone, G.C.B., O.M. (president), Sir J. J. Thomson, O.M., F.R.S., Hon. Sir C. A. Parsons, K.C.B., F.R.S., Dr. G. T. Beilby, F.R.S. The Consulting Panel will comprise the following list, which will be added to from time to time as necessary:—Prof. H. B. Baker, F.R.S., Prof. W. H. Bragg, F.R.S., Prof. H. C. H. Carpenter, Sir William Crookes, O.M., F.R.S., Mr. W. Duddell, F.R.S., Prof. Percy Frankland, F.R.S., Prof. Bertram Hopkinson, F.R.S., Sir Oliver Lodge, F.R.S., Prof. W. J. Pope, F.R.S., Sir Ernest Rutherford, F.R.S., Mr. G. Gerald Stoney, F.R.S., Hon. R. J. Strutt, F.R.S. The Board is accommodated temporarily in the Whitehall Rooms, Hotel Métropole, Whitehall Place, S.W., but at an early date (which will be announced in due course) it will be transferred to permanent offices at Victory House, Cockspur Street, S.W. Communications should be addressed to the secretary, Board of Invention and Research.

We regret to announce the death in action on the western front, on Saturday, July 10, of Lieut. Ernest Lee, a young botanist of considerable promise, who had already published some excellent work, notably a paper in 1911 on leaf-fall. Lieut. Lee obtained a national scholarship in 1906, and while at the Royal College of Science, South Kensington, was both Marshall scholar and Forbes medallist. He was an associate of the Royal College of Science and a fellow of the Linnean Society. In 1910 he became assistant lecturer in the botanical department at the Birkbeck College, London, and in 1913 went to the University of Leeds as a lecturer in agricultural botany. He there became a member of the Leeds O.T.C., and obtained a commission in the Duke of Wellington's Regiment soon after war broke out. In the autumn of 1914 he married Miss H. S. Chambers, lecturer in botany at the Royal Holloway College. Lieut. Lee was killed instantaneously by a bullet while with his guns, and he will be greatly regretted by all who knew him or his work.

Last week we recorded with regret the death, at the age of twenty-seven, of Mr. H. S. Bion, assistant superintendent of the Geological Survey of India. Mr. Bion was born in India, and was educated at the School for the Sons of Missionaries at Yvesdon House, Blackheath, and at University College, London. His university career was a distinguished one. In 1905 he obtained the university scholarship in geology, and in 1906 the Morris geological prize. In 1908 he took the degree of B.Sc. in the University of London, obtaining first-class honours in geology. In 1911 he was elected a fellow of the Geological Society. In February, 1911, he joined the Geological Survey of India, and in the following November he was appointed curator of the museum and lecturer in the Presidency College, Calcutta. His work in the field was chiefly in Burma and Kashmir, and he did particularly valuable work in the latter area, especially among the Carboniferous rocks. His marked ability, his unselfish character, and scientific enthusiasm, endeared him to all with whom he came in contact, and his untimely death is deeply regretted by his former teachers in this country, his colleagues of the Indian Survey, and his numerous friends.

By the death of Mr. R. W. Raper, fellow, vice-president, and bursar of Trinity College, the University of Oxford has suffered a serious loss. For some time his health had been failing, but the news of his sudden decease has come as a shock to his friends in Oxford, who had seen him walking about as usual up to within a very recent period. Mr. Raper was one of the best known and most highly respected of Oxford residents. His services to his college were of great value. The combination of clear-headed business aptitude, firmness in action, and humorous but not unsympathetic methods of dealing with difficult situations made him an almost ideal college bursar. Countless undergraduates have good cause to remember his generous friendship and refined hospitality. As a promoter of public interests he did a great work, both in his University and in his paternal home at Malvern. Oxford holds in especial gratitude his action in defending the top of Shotover Hill from enclosure. The preservation of beauty, whether in nature or in art, always found in him an enthusiastic champion.

HERBERT KYNASTON, whose death was recorded in our issue for July 15, was the son of the late Dr. Kynaston, Canon of Durham, and was born on July 19, 1868. He entered King's College, Cambridge, making a special study of geology, and securing a first class in part ii. of the Natural Sciences Tripos in 1891. He proceeded to examine the volcanic rocks of Old Red Sandstone age in the Cheviot Hills, and was appointed an assistant geologist to the Geological Survey (Scottish Branch) on May 3, 1895. His first official work lay among the Old Red Sandstone rocks of Lorne and Glencoe, and he made important contributions to the Memoirs on Mid-Argyll and the Oban and Dalmally districts. He resigned his post in January, 1903, to take up the difficult duties of director of the reconstituted Geological Survey of the Transvaal, and numerous members of the British Association will recall his kindly guidance during a memorable visit to South Africa in 1905. The first report under his auspices, that for 1903 (see NATURE, vol. lxxi., p. 53), contains a paper by him and his colleague, A. L. Hall, on diamond-bearing pipes and alluvial deposits. He described in later reports the Komati Poort coalfield and the tin-deposits of Waterberg, south of the Limpopo, and much of his work had to be carried on in advance of the mapping of the country. When, under the Union Government, the Geological Surveys of the provinces were united, Kynaston was selected as director, and he initiated the series of Memoirs of the Geological Survey of South Africa. His death at Pretoria on June 28, 1915, at the early age of forty-six, will be regretted as much in Scotland as in South Africa, and some of his observations on the Glencoe area are embodied in a memoir that is still passing through the press. One of his colleagues writes of him with simple feeling as a man who was "a true friend, of quiet disposition, but full of kindly humour and affection."

WE learn from *Science* that Dr. Viktor von Lang, emeritus professor of physics at Vienna, has been elected president of the Vienna Academy of Sciences. The academy has elected as corresponding members Dr. Sven Hedin, Dr. Max Planck, professor of mathematical physics at Berlin, and Dr. P. H. von Groth, professor of mineralogy at Munich.

THE Livingstone gold medal of the Royal Scottish Geographical Society has been awarded to Lord Kitchener in recognition of his work on the survey of Palestine, and as a director of the survey of Cyprus, as well as in recognition of his signal services to the State. The society's gold medal has been awarded to Dr. J. Scott Keltie, late secretary of the Royal Geographical Society, in consideration of his services to geographical science.

WE regret to record the death on June 18 of Mr. T. D. West, at Glenville Hospital, Cleveland, Ohio. *Engineering* for July 16 contains a brief account of his career. Mr. West was born in Manchester in 1851; his parents emigrated to the United States when he was an infant. He entered a foundry at the age of twelve, and was connected with foundry work throughout his life; he was a recognised authority on subjects pertaining to foundry work. At the time of his death he was chairman of the West Steel Casting Co., Cleveland. He was a member of several American societies, and was the author of several books and pamphlets on foundry practice.

THE annual meeting of the general committee of the Imperial Cancer Research Fund was held on Tuesday, July 20, Sir William Church in the chair. The work of the fund has been greatly curtailed owing to the war, and the scientific part of the annual report is restricted to a summary of the work published during the year. The work comprises an experimental study of metastasis, which emphasises the importance of the processes at the site of arrest of tumour emboli, an investigation into immunity to transplanted sarcomata extending the well-known findings with regard to carcinoma to the connective tissue tumours, and biochemical studies. The two biochemical papers deal with the action of ferments. The first is concerned with the effect of minute alterations in the reaction of the medium on the activity of a maltose hydrolysing ferment. The second deals with the action of the protein-splitting ferment present in normal serum of man and animals as accounting for the phenomena comprised in the Abderhalden serum reaction. The conclusion is drawn that the doctrine of specific protective ferments set up by Abderhalden is unsound, and that the reaction even in its improved form cannot be relied on for the serum-diagnosis of pregnancy or cancer. The report also discusses the pathological bearings of the new and interesting data in the Registrar-General's Report for 1913 on the influence of marital condition in women on the mortality from cancer of organs special to their sex.

THE *Engineering Magazine* for July contains an interesting article on war orders and their effects on American industry. Sales of benzol have been much stimulated by the war, and the price has been quintupled. American makers of explosives have had two problems to solve, first, to expand their plants; secondly, to change over their processes to make foreign powder. These, together with the problem of securing a sufficient supply of raw materials, such as benzol, have been pretty well solved, and the production of explosives is proceeding on a tremendous scale. Many makers who have undertaken orders for shells have made heavy purchases of machine tools for executing the orders; these firms have been unwilling to fill their existing plants with such special work at the expense of inconveniencing their regular customers. Evidently these firms are looking for a strong revival in domestic demands. The Westinghouse Electric and Manufacturing Company, after accepting a large order for rifles, bought two plants—the Stevens Arms Company and the Stevens-Duryea Automobile Company—in order to take care of the work outside of its Pittsburgh plants. Mr. J. F. Wallace, formerly chief engineer of the Panama Canal, thinks that, as a consequence of the huge orders placed, the United States will have the means of providing for national defence; the plants now used for supplying European requirements could be used to equip home armies in a remarkably short time. In other words, the United States has obtained insurance against attack for practically nothing, so far as equipment preparation will provide.

IN the July issue of *Man* Mr. E. J. Wayland describes a series of stone implements collected by him on the Monapo river in the Portuguese province of Mozambique, East Africa. All, with one possible exception, are extremely crude, being chipped out of nodules of chalcedony and jasper with which the basalt ridges of the sedimentary coast belt are bestrewn. There is no certainty about their age, the fact that they are found on the surface not necessarily showing that they are of comparatively modern date. They closely resemble those found by Mr. Lamplugh near the Victoria Falls. No local evidence justifies their attribution to a period earlier than the early Palæolithic, but they may be of much later date.

IN *Man* for July Dr. W. H. Rivers describes specimens of the boomerang found on the coast of Espiritu Santo, New Hebrides. They differ from the Australian type in having the ends almost square or showing a slight curve not continuous with the general curvature of the implement. The antiquity of the use of the boomerang in the New Hebrides may be assumed from its connection with tribal rites, and one group claim descent from it. This discovery raises an important problem. The weapon is generally regarded as an ancient element in Australian culture, but Dr. Rivers suggests that it was introduced by the race which, in his studies on Melanesian social life, he calls the Kava people. The discovery is, he thinks, sufficient "to put us on our guard concerning the supposed antiquity of the Australian boomerang, for in spite of their difference of form, there can be no reasonable doubt that the Australian and Melanesian instruments are but divergent manifestations of the handiwork of one people."

IN his presidential address to the Royal Society of South Africa (May 19) Dr. L. Péringuey summarised the conclusions he has reached regarding Palæolithic man in South Africa. He still maintains that the early Palæolithic cultures—Chellean, Acheulean, and Mousterian—which occurred in sequence in Europe, existed together in South Africa. The later Palæolithic cultures, particularly the Aurignacean and Solutrean, are richly represented in South Africa, where they are associated, as in Europe, with a particularly realistic form of art. The evidence which associates the later Palæolithic cultures with the ancient Bushman is, in Dr. Péringuey's opinion, now quite complete. He endeavours "to show that the Bushman, if himself not the ancestor of those Solutrean and Aurignacean people, may have been of them, and that he has retained many parts of their handicraft is equally certain." Dr. Péringuey is prepared to believe that the later Palæolithic cultures of Europe were introduced from South Africa.

THE Hydrachnidæ, or water-mites, are favourite subjects of study for students of "pond-life." Such students are indebted to Messrs. W. Williamson and C. D. Soar for an illustrated account of the genus Lebertia, which appears in the Journal of the Quekett Microscopical Club, vol. xii., No. 76.

A RECENT number of the *Philippine Journal of Science* (vol. ix., section D, No. 4) is almost filled by an exhaustive account of the Palæmons of the Philippines by Dr. R. P. Cowles; a feature of the paper is the careful series of measurements of the segments of the chelate thoracic limbs in the various examples of each species described.

DR. A. RANDELL JACKSON, whose studies in British spiders are well known, has published (Proc. R. Phys. Soc., Edin., vol xix., No. 7) a "Second Contribution to the Spider Fauna of Scotland." This includes a Clubiona, hitherto undescribed, and several species not before found in Great Britain. As might have been expected, Ben Nevis and the Cairngorm group of summits proved exceptionally good collecting grounds. But why does the author write "Ben McDhui," as if the famous Aberdeenshire mountain were named after a Highland clan, instead of preserving the original "Ben Muich Dhui" (="Mount of the Black Hog")?

MANY marine animals of high interest have been made known through the activities of the Irish Fisheries Surveys. Some new light on the life-history of echinoderms has been shed by larvæ dredged or tow-netted off the south-west coast of Kerry, and described by Dr. J. F. Gemmill (Proc. R. Phys. Soc. Edin., vol. xix., No. 7). A single Brachiolaria larva, resembling that of *Asterias rubens*, is carefully figured; it was taken in a tow-net at 1150 fathoms' depth. An advanced bipinnaria stage, found in five different localities, and referred to *Luidia ciliaris*, is also described and drawn.

ORNITHOLOGISTS may turn with profit to some "Notes on the Moults and Sequences of Plumage in Some British Ducks," by Miss Annie C. Jackson, which appear in the July issue of *British Birds*, for there are yet some who hold that a colour change without a moult is not only possible but demonstrable, a conclusion based on an inability to weigh evidence and a want of knowledge of the structural peculiarities of feathers. But the merit of Miss Jackson's paper lies not so much in controverting these fallacious arguments as in establishing the fact that female surface-feeding ducks undergo a complete moult in the spring. This moult extends also to the underclothing of down-feathers. But by far the most important item in her work is the discovery that at this spring moult an additional form of down, longer and coarser, is developed, apparently to serve as a lining for the nest. Presumably this peculiar type of down is developed on the breast alone. Further particulars of the structural peculiarities of this down, which disappears with the autumn moult, would be acceptable.

A VERY useful summary of what is known in regard to the emission of light among insects is given by Mr. K. G. Blair in the Proceedings of the South

London Entomological and Natural History Society, 1914–15. Original observations, made by the author himself, add materially to the value of this contribution. Originally, it is assumed, developed as a protective device against enemies—the light-emitting qualities being associated with, or perhaps the cause of, nauseating properties—luminosity has become primarily a secondary sexual character. This much is attested by the response which can be obtained by experiment from the use of small electric bulbs. These experiments conclusively show that each species has its own characteristic method of exhibiting its light, and that an individual from any one species will, as a rule, only respond to, or evoke an answering flash from, a member of the opposite sex of that species. Some species, moreover, respond more readily to artificial flashes than others. Some will even answer the flash of a match. Luminosity in some cases, however, seems to play a directly utilitarian part, as in the case of the fly *Thyreophora cynophila*, which is said to be nocturnal in habit, and to feed on dead bodies by the light of its phosphorescent head. Finally, the author discusses numerous instances of pathological luminosity due to luminous bacteria, as in the cases of certain midges and crustacea.

Students of genetics, no less than systematists, will welcome the "Review of the South American Sciuridæ," by Mr. J. A. Allen, which appears in the Bulletin of the American Museum of Natural History, vol. xxxiv., 1915. In discussing the value of size as a "group character," the author remarks that closely related forms present a small average range of variation, *inter se*, and a very wide range of individual variation. Specificity is determined, not by individuals, but by groups of individuals. In attempting to discover tangible differences in the form of the skull and the character of the teeth in American squirrels, with a view to their use as the basis of generic or subgeneric divisions, some surprises were met with in respect to the variability of such features in specimens of the same species from the same locality. The form and the details of the crown pattern of the last premolar and the last molar were found to be extremely unstable features. The author also makes some extremely interesting observations on colour variations and the evolution of new types of coloration.

From the Department of Agriculture, Ceylon, have been received Bulletins Nos. 12, 13, and 14, dealing with Hevea tapping results at the experiment station, Peradeniya, the tapping of an old Hevea tree at Heneratgoda, and manuring of cacao at Peradeniya respectively. The old Hevea tree is apparently one of the original trees sent out from Kew in 1876, and its girth in August last was 117 in. at 3 feet from the ground. The tree has been tapped with short intervals over a period of 4 years 9 months, and the total yield of rubber has been 392 lb. 7 oz.

The Polyporaceæ of Wisconsin form the subject of Bulletin xxxiii. of the Wisconsin Geological and Natural History Survey. This great family of fungi, which has been worked out by Mr. J. T. Neuman, is represented in Wisconsin by a great number of species, and Cyclomyces is the only genus unrecorded. The bulletin consists of 148 pages of descriptive text with twenty-five plates of figures, which should enable the fungi to be easily identified. As many of the Polyporaceæ are serious timber-destroying fungi the book should prove of value in the United States. Of the destructive forms, *Polyporus abietinus*, *P. pergamenus*, growing on maple, willow, oak, etc., *Trametes pini* and *Fomes ungulatus*, cause the greatest damage to timber trees.

We have received a copy of a new publication entitled "Egyptian Agricultural Products," published by the Ministry of Agriculture, Egypt, dealing with *Sorghum vulgare*, Pers., the great millet and its varieties, and also with *S. halepense*, Pers. The account, No. 1a, 1915, has been compiled by Mr. G. C. Dudgeon, consulting agriculturist to the Ministry of Agriculture, Egypt. Botanical descriptions of the types and the varieties are given, followed by details of the history of the great millet in Egypt, and full cultural details. It seems probable that *S. halepense*, which is indigenous in Egypt, is the plant from which *S. vulgare* and its numerous varieties have been evolved. The uses of the grain and the leaves are also dealt with, and the question of the poisonous character of the young leaves is discussed. When grown under dry conditions the young leaves appear to be more poisonous than when grown moist, but as the toxic properties are destroyed by heat the precaution is always taken of exposing young leaves to the sun for some time before feeding them to cattle. When mature the leaves afford a safe cattle food.

The first volume of the Agricultural Statistics of India (1912–13) is particularly valuable on account of the new features, which include charts, summary tables, and a comprehensive introductory report. The charts indicate considerable progress since 1901, and the increased acreage devoted to cultivation has been accompanied by an improved yield in the crops. The decline in the acreage devoted to indigo and opium continues; and the minor fluctuations in area under the other crops are shown to be largely due to rainfall deficiencies In a comparative statement it is shown that India has under rice more than eleven times the area of the paddy fields of Japan, that India is the third country in the world in regard to acreage under wheat, since there is under that cereal three times the Canadian area and three-fifths that of the United States, that India has the largest acreage under maize outside the United States, and that the area under cotton in India is three-fifths that of the United States and twelve times that of Egypt. This issue may be regarded as the first of a new series of annual reports.

An important contribution to the geography of Canada has been made by Mr. J. B. Tyrrell, of the Geological Survey, in a paper reprinted from the Transactions of the Royal Canadian Institute, Toronto, entitled "Algonquian Indian Names of Places in Northern Canada." In the course of fifteen years' service in that region Mr. Tyrrell made extensive inquiries from natives regarding the original names of the chief physical features in the Cree and Ojibway languages. He gives a long list of the native names with those now current. In some cases the native name has been preserved with more or less modification; in others it has been replaced by a translation into English; in others, again, it has been replaced by a purely English designation. Thus a place which in the native tongue was called by a name meaning "A Hole through the Earth," has become "Oxford Lake." The native terms now recorded throw welcome light on the proper pronunciation of geographical terms. It is to be hoped that these names will now be systematically recorded before they finally disappear. Such lists may supply some information on Indian tribal history before the entry of Europeans into the country.

ALTHOUGH the genesis of the various thirty-two systems of crystallography has formed the subject of numerous writings at the hands of Hauy, Brocke, Bravais, Schoenfliess, and others, a suggestive note contributed to the *Atti dei Lincei*, xxiv., 7, by Dr. C. Viola throws new light on several portions of the subject. Instead of basing his classification on symmetry, he classifies the principal six systems by means of the properties of zones normal to faces, proving the following theorems:—A plane of symmetry is a face and is normal to a zone; an axis of symmetry is a zone, and is normal to a face; a zone which is normal to a face is necessary for the existence of a plane of symmetry or of a symmetrical or specular axis; two zones normal to faces and inclined to each other involve the presence of a zone orthogonal to them, and as many zones normal to faces as there can be in their common plane; two orthogonal zones normal to faces involve the existence of a third, and only a third, zone normal to a face; three zones normal to faces inclined to each other are sufficient and necessary conditions that every face should be normal to a zone. These theorems establish the existence of the following systems: triclinic, monoclinic, trimetric, dimetric, hexagonal, and monometric. It is pointed out that similar methods are applicable to investigate the properties of systems other than crystals.

MR. W. THOMSON described to the Manchester and Salford Sanitary Association on July 6 an ingenious method for obtaining a dust and smoke record. A hollow brass cylinder has a small slit cut in the side over which a ribbon of filter paper is stretched, whilst the air is passed through the paper by exhausting the interior of the cylinder. After a half-hour's exposure the ribbon is automatically moved on and a fresh surface exposed. In this way the fine dust and smoke are deposited in rectangular patches at half-hour intervals, and the depth of colour produced can be used as a means of comparison over any desired period. It appears that in Manchester, where the investigation was carried out, the atmosphere is most polluted on Mondays and Tuesdays and least on Sundays.

PART 3, vol. v., of the Journal of the College of Agriculture, Tokyo, is almost entirely devoted to mycological researches, and it forms a very important addition to the literature on the subject. With one exception the papers are printed in English, and it is to be hoped that one desirable result of the present disastrous war will be the spread of English in preference to German in the scientific literature of Japan. The papers are illustrated with plates of great accuracy and beauty, which testify to the care with which the investigations have been performed. Indeed, they would appear to rank with those carried out in the famous Carlsberg Laboratory of Copenhagen. It is interesting to note the developments caused by the intrusion of chemistry into mycology—the Saccharomyces are characterised to-day as much by their selective behaviour towards various carbohydrates and amino-compounds as by their morphological characters.

FERMENTED beverages have always been the hunting-ground of the mycologist, and the majority of the known species have been obtained from this source. The beverages of the Far East are quite peculiar in the nature of their ingredients, and experience has demonstrated that they contain a unique flora of Saccharomyces. The latest Chinese beverage to be studied is "Shaoshing-chu," of which very large quantities are manufactured in the province of Chü-Chiang. Mr. Takahashi describes (Journal of the College of Agriculture, Tokyo, vol. v., p. 200) several varieties of *Saccharomyces shaoshing*, a new species of yeast analogous to saké yeast, as well as four new forms of a *Zygosaccharomyces shaoshing*. The same number of the journal describes the budding fungi of a beverage made from a mash of steamed soy bean and roasted wheat. Five different Zygosaccharomyces were isolated. The assimilation of amino-acids from their pabulum by these yeasts is studied in detail, and the interesting fact established that it is materially smaller than in the case of saké yeast. Another Japanese beverage of which the soy bean forms the basis is "Hatsuchō-miso." This generally takes from three to five years to ripen, and is highly valued on account of its special aroma and taste. A preliminary investigation of the fungi present and the chemical changes occurring during the ripening indicates that the quantity of amino-acids present in the mash is an important factor, and there is a probability that such work will lead to the improvement of the product.

OUR ASTRONOMICAL COLUMN.

A BRIGHT METEOR, JULY 17.—A brilliant, swift meteor (=Venus) was observed by Mr. H. E. Goodson at the Hill Observatory, Salcombe Regis, on July 17, 10h. 54m. p.m. G.M.T. The path practically crossed δ Scorpionis, and was directed towards 42 Librae. The trail, about 3° long, persisted several seconds.

THE DETERMINATION OF EASTER DAY.—Anyone who desires a clear and simple account of the principles on which the determination of Easter Day depends may be recommended to consult a paper by Dr. A. M. W. Downing, which was read before the Victoria Institute on March 15 of this year. The problem involves the combination of the three incommensurable periods, the week, the lunar month, and the tropical year, and has been further complicated by changes in the calendar. The way in which the adjustment has been effected to comply with the primitive ecclesiastical rule is here explained in untechnical language and with much interesting historical detail. A discussion of the more comprehensive mathematical rules, like that of Gauss, would have been outside the scope of the paper, which deals rather with the construction and use of the Prayer Book tables. Some account is also given of the Jewish calendar, with some reference to the astronomical evidence bearing on the date of the Crucifixion. The paper was followed by a discussion, which is reproduced with it.

Dr. Downing expresses himself in favour of making Easter Day a Sunday in a fixed week, remarking that the lengthy explanations required by the present system make a strong argument in favour of this course. But, as he admits, no change is feasible which does not carry with it universal agreement. It is a little difficult to appreciate the opposition to a fixed Easter, which found expression in the discussion following the paper. The association of ecclesiastical festivals with certain astronomical conjunctions is intelligible, even if it fails to carry sympathy. But this is precisely what the present artificial rules do not secure, a fact illustrated in the year 1905, alluded to by Dr. Downing, when Easter Day fell four weeks later than it should have done according to the real moon, and also by the complete variance between the Eastern and the Western churches. The opposition between religious sentiment and practical convenience would probably change in form if, instead of suggesting a fixed Easter, it were proposed to fix the dates of all public holidays, and so to dissociate them from all religious observances.

CEPHEID-GEMINID VARIABILITY.—In the *Astrophysical Journal* (vol. xli., No 4, pp. 307–14) Mr. C. D. Perrine brings forward a tentative explanation of this type of stellar variability based on an inquiry into their orbital characteristics, etc. Discussion of data regarding thirteen stars indicates that the conditions requisite for the production of such variables are large eccentricity combined with small distance between components and small mass of secondary. The few cases of F- and G-type stars other than the variables in question with similar masses of secondaries and orbital dimensions have small eccentricities and show no variation in brightness. It is therefore suggested that the variation of light is caused chiefly by changes in the light of the *secondary* due to disturbance in the part of its orbit near periastron, the maximum of light occurring at about the time of maximum approach of the primary.

VARIABLE STARS.—A series of notes and data dealing with various subjects related to stellar variability is contributed by Dr. Harlow Shapley to the *Astrophysical Journal* (vol. xli., No. 4, pp. 291–306). Some of the observational work was carried out at the Princeton University Observatory, but the material was worked up at Mount Wilson. Using the bolometric observations of the Astrophysical Observatory of the Smithsonian Institution, Dr. Shapley has been able to investigate the darkening towards the limb of the sun in comparison with the similar darkening revealed by the study of eclipsing binaries. It has now been found that, although the empirical formula adopted at Princeton in the case of eclipse variables does not completely represent the solar darkening, the agreement is nevertheless quite close, the error being generally less than 1 per cent. It is also found that the darkening coefficient varies with the number of sun-spots, more especially for light of shorter wavelengths; a variable darkening coefficient is thus suggested. Another note contains some interesting conclusions regarding the periods and spectra of close binary stars. The data employed by Wicksell in a similar investigation has been legitimately extended by the inclusion of eclipsing variables. Cepheid variables were, however, eliminated, Dr. Shapley having come to the conclusion that they are not binary systems (see NATURE, vol. xciv., p. 572). Thus modified, the data does not show the secondary maxima of period found by Wicksell, except in the case of B-type stars. The maximum number of periods are between 2·5 and 6 days. Other notes deal with variable stars U Pegasi, *o* Persei, R. Canis Major, and AE Cygni, and the number of naked-eye variables.

THE SOCIETY OF CHEMICAL INDUSTRY.

THE Manchester meeting of the Society of Chemical Industry on July 14–16 was by far the most important gathering of chemists since the commencement of the war, and its success augurs well for the future of the society. Hitherto the annual meetings have been largely of a social character, and though they have served a valuable purpose in promoting personal friendships, it has been widely felt that the society has not taken full advantage of the opportunities for the discussion of industrial problems which the annual meetings provided. It was obvious this year that social functions were entirely out of place, and the organising committee devoted their efforts to securing discussions of matters of prime importance to British chemical industry.

At all the sittings, and still more in the general conversations, there was a consensus of opinion that the time had come for the society as a body to take active action in regard to these matters. The gathering was a representative one, and was largely attended by the industrial chemists of the Manchester and Liverpool districts, and also by those further afield, in spite of the calls on their time made by war work. The academic element was very well represented, a noticeable feature being the presence of many of the professors recently appointed to act in a consultative capacity to the national dye scheme. Although visits to chemical works did not form part of the official programme, there was marked evidence on the part of manufacturers to oblige in this respect, showing that the need of greater co-operation amongst our chemical industries to meet foreign competition was not overlooked.

The themes underlying all the papers, as well as Prof. G. G. Henderson's presidential address, were the same—the need of closer co-operation between the manufacturer and the chemist, and the necessity of improving the training, not so much of the would-be chemist, as that of the managing classes of the community so as to bring about a better appreciation of what science and scientific method really are, and how they can be turned to practical account. Not less important is the necessity of organising industrial chemists as a whole, so that they can speak authoritatively and with a certainty of being heard in the counsels of the nation.

The discussions were to the point, and were brief, largely because the meeting was in entire agreement with the suggestions before it. A greater public participation in them by the representatives of industry might have produced new facts and suggestions, and the president should have made a more direct appeal on these grounds. Judging from what was said in private, the view-point of the man engaged in industry is imperfectly appreciated by the professor, and as the latter is more generally heard on the public platform, there is a danger of the practical side of the issues being insufficiently represented. This is particularly the case in regard to the many committees appointed in connection with the war, on which the chemical manufacturer is very inadequately represented.

Prof. Henderson, in his presidential address, considered that the comparative failure of chemical industry in this country was due to the lack of appreciation of research, to the absence of co-ordination between manufacturers and professors of chemistry, and especially to the lack of provision for enabling men of academic training to apply their knowledge to industry. This last is undoubtedly one of the greatest difficulties, and to meet it he advocated a scheme of industrial fellowships on the lines of that introduced in America by the late Prof. Kennedy Duncan. A discussion on this point would have been illuminating, as there is no doubt that in the opinion of the manufacturer much of the product of the modern university training is disappointing. The excessive devotion to physical and theoretical chemistry, an insufficient knowledge of general chemistry, poor manipulative power, and lack of ability to tackle even simple problems are the common defects in their training, and if, as is usually the case, these manifest themselves after the newcomer has been taken into the confidence of the firm, the result is to shake the confidence of manufacturers in the university chemist. The ability of the chemist to take charge of a process is a natural rather than an acquired gift, but it is essential if the works chemist is to make material progress in the scale of promotion, as it is only the largest firms which can afford to maintain a large staff of highly-paid research chemists.

Dr. M. O. Forster also emphasised the chasm between the college and the factory as responsible for much mischief, and would appear to put the blame largely on the factory. It is a pity that a further paper on this subject was not secured from a responsible person in one of our largest chemical works, as there is a strong counter-feeling prevalent that the college and the scientific societies, by holding aloof from the factory, tend to place industrial chemists on a lower plane in the profession, and debar the most gifted students from entering the factory.

An address by Prof. H. E. Armstrong dealt with the need of organisation within the industry for the purposes of development and the protection of the interests of industrial chemists. He emphasised particularly that chemistry had not attracted the right stamp of man—one of generous mind, good presence, and real ability—in sufficient numbers. They looked to the older universities, particularly to Oxford, to supply this type, whereas the universities, owing to their neglect of the science schools, encouraged their graduates to take up law, mathematics, or classics. Such material would be worth, and would command, good pay when properly trained. The desire for a scientific vocation must begin in the schools, and schoolmasters must encourage their best pupils to this end instead of advocating classics, because the immediate prospect of scholarships at the university was greater. The success of German chemical industry is due to two causes; first, the fact that their universities are practical institutions properly supported by the State, and in touch with the educated community; and, secondly, the factories are in the hands of experts. The development has been from within, though it has received great assistance from public sources. The academic party has worked under conditions of freedom, of *Lehrfreiheit* and *Lehrnfreiheit*, whereas in England the tradition that it is necessary to be well-read instead of well-practised has prevailed.

Dr. Beilby, in a paper on chemical engineering, distinguished between the engineer proper and the chemical engineer, rather to the detriment of the latter, though he does not overlook the fact that, if the engineer is not in full sympathy with chemical problems, and acquainted with the action of chemical substances on his materials, his plant will be a failure. The chemical works engineer is called a more adaptable but a rougher type of man, though it is afterwards admitted that he is "born, not made." It is the possession of large numbers of highly, specially trained chemists and engineers which gives the German chemical works its commanding position.

THE NATIONAL PHYSICAL LABORATORY IN 1914–15.

ANY review of the work of the National Physical Laboratory during the year 1914–15 should be prefaced by a tribute to the ready response with which the staff greeted the call to the colours at the outbreak of war. In the annual report of the laboratory, presented on June 15, at the Royal Society, to the General Board, attention is directed to the consequent marked reduction in the staff and its effect upon the distribution of duties. Many who were prepared to volunteer had to be retained by reason of stress of war work. Some 25 per cent. of the total staff were spared for service.

Dealing with matters of finance, a recovery in receipts since September and the maintenance of a stringent economy throughout contributed to a year's total which was not so unsatisfactory as had been apprehended during the earlier stages of the war. The report points out, however, that an enforced economy may well, if too long continued, prove disastrous. Special mention must be made of the generosity of the Hon. Sir C. A. Parsons, in placing a sum of 1000*l*. at the disposal of the committee; this enabled some serious gaps in equipment to be filled. Steps were taken in July, 1914, to proceed with a recommendation of Lord Parker's Committee on Research in Telegraphy and Telephony, on which the director of the laboratory, Dr. Glazebrook, was serving. It was proposed to establish at Teddington a National Telegraphic Research Laboratory. Since the outbreak of war, however, the matter has been in abeyance.

With regard to test work it may be said, in brief, that the war conduced to a shrinkage in aggregate, but, at the same time, to a large increase in some directions, notably in the electrotechnics and the optics divisions. International work of all kinds has practically come to a standstill. It should further be emphasised, before touching more specifically on the progress of the laboratory during the year, that the research work had, by force of the abnormal conditions prevailing, to be diverted in a large measure to abnormal channels.

A full list of papers published by, or communicated from, the laboratory during the last two years will be found in the report. The twelfth volume of "Collected Researches" is shortly to be issued.

To pass to a few details of the report, mention should in the first place be made of a series of inter-comparisons made during July last in collaboration with two visitors from the Physikalisch-Technische Reichsanstalt, Dr. Giebe and Dr. Scultze, between laboratory standards of resistance and inductance and some coils the absolute value of which had been determined previously at Charlottenburg. Further international measurements may also be noted. In Japan, differences of the order 8 parts in 1,000,000 were found between five mercury resistance standards, which had been constructed at the laboratory, and five tubes calibrated at Tokyo; whilst four Weston cells brought from Petrograd to Teddington agreed with the mean laboratory standard to within 1 part in 100,000. *Inter alia*, an important investigation of the irregularities commonly observed in the Weston normal cell was brought to a close during the year. An interesting series of experiments was also carried out in connection with the measurement of high-frequency currents. With suitably designed air- or iron-cored transformers it was found possible to measure, with precision, currents ranging from 1 to 50 amperes at frequencies from 50,000 to 2,000,000 ~ per sec.

Two valuable photometric papers claim attention. These deal with the unit of candle-power in white light, as held in electric substandard lamps, and with the estimation of high temperatures by a method of colour identity. Reference may here also be made to the first report issued by the Committee on the Lighting of Factories and Workshops, of which the director of the laboratory is chairman. In the direct-current division good advance is reported with the research on the heating of buried cables.

With the co-operation of Dr. Schultze, two standard resistance thermometers, the constants of which had been studied at the Reichsanstalt, were re-examined at the laboratory. Owing to the war, no official comparison of the Reichsanstalt and the laboratory figures has been possible; but the two sets are known to be in close agreement. In a revision of the high-range mercury standard thermometers valuable assistance was given by Dr. René Paresce, of the Bureau des Poids et Mesures. The heat division was also occupied with research on refractory materials and on heat loss from surfaces.

In the metrology division the silica standard metre was kept under close observation, and it is promising to hear that no measurable extension could be detected during the year. Other items of interest are a series of rulings, undertaken for Prof. W. H. Bragg, to illustrate his work on X-ray spectra, and a report issued to the Board of Trade on leather-measuring machines and templates.

In spite of the absence of Dr. Kaye on active service, the radium division flourished during the year. Samples amounting to the value, 35,000*l.*, were submitted for test; up to March, 1914, the corresponding figure was 3000*l.* The division promises to thrive.

Not more than a broad selection can here be made from the numerous investigations of the engineering department. These range from experiments on the resistance of materials to alternating shear and combined stresses to an examination of cracks in the Tower of London. Considerable progress was made with a research on the methods of notched-bar impact testing, which is mainly concerned with a determination of the correct relation between the mass of the hammer, the velocity of striking, and the linear dimensions of the specimen, in order that tests on similar specimens on different scales may yield consistent results. Attention may also be directed to a report on power transmission through motor gear-boxes. On varying the quantity and the viscosity of the oil in such boxes, surprising alterations in efficiency were observed. Passing to the aeronautical division, the new 7-ft. wind channel is now in full working order. The researches of this division on the longitudinal and lateral stability of aeroplanes are well known, and call for no review here.

Interesting profiles of road surfaces at various stages in test were obtained by the Road Board laboratory, and numerous road materials examined under the microscope and otherwise.

Of the work accomplished during the year by the department of metallurgy, it must suffice to instance important researches on the constitution of aluminium-zinc-copper and copper-tin alloys, and an investigation of a new reagent for etching steel. Mention should also be made of some tests carried out by the chemical division on optical glasses, and of a report issued to the Board of Trade giving the results of an investigation into the precautions necessary in the transport of barium peroxide at sea. Some serious fires at sea, notably that on the *Volturno* in October, 1913, have been attributed to the spontaneous ignition of cargoes of this substance. Results of great interest will be looked for from the newly-erected rolling mill.

Compared with last year's abnormal figure, the number of models for private firms tested this year in the National Tank proves somewhat moderate. By suitable form modification, reductions of power at service speed, ranging to 13 per cent., were secured. Various researches were either continued or completed. In conjunction with that relating to fulness of form and longitudinal distribution, special study was made of the wave systems formed by the models. Furthermore, attention was directed to the question of the similarity law suitable for strut-resistance. Unless suitably corrected, the resistance of a full-scale strut may, on the basis of measurements on a model, prove enormously over-estimated.

That for a brief review numerous items of interest must pass unmentioned is inevitable. Sufficient, however, has been said to testify to the energy and success with which the work continues to be carried on despite adverse circumstances. It is to be hoped that, during the present emergency, every advantage will be taken of facilities which the laboratory can offer. Perfection and efficiency in all supplies of instruments and technical apparatus, with expedition in dealing with special questions, spell success to those fighting on sea and land.

HEATING AND VENTILATING SYSTEMS.

MR. D. D. KIMBALL, the president of the American Society of Heating and Ventilating Engineers, and a member of the New York State Commission on Ventilation, has sent us two papers, one on the heating and ventilation of school buildings, and the other on church ventilation. He says that most of the failures of the past may be justly attributed to insufficient appropriations for the installation of ventilating systems and for their maintenance and operation. Very many installations are incomplete, ill-designed, and installed with the use of unsuitable and cheap apparatus. Possibly the most frequent and serious cause of failure is the want of proper skill in operation. Plants are operated by boys or janitors who know absolutely nothing of the rudiments of fuel-burning, or care of a steam plant, or of a ventilating system. Often, too, there are such restrictions applied by the authorities that the proper operation of the plant is impossible. A school board, for example, directs that the plant must not be operated before or after certain dates, regardless of outside weather conditions, or offers a bonus to the janitor for saving coal, and yet directs that he must always operate his fan engines. He removes the belt between engine and fan, and so secures his bonus.

Mr. Kimball rightly insists on the heating and ventilation of schools being considered of the first importance in the estimates of any public building. Far too much is thought of the external appearance. The architecture should be adapted to the perfection of the physiological needs of the occupants, and the heating and ventilating engineers should be of equal authority with, not subservient to, the architect. A plan is given of the Wm. H. McKelvey School, of Pittsburgh. The air is taken through windows into a fresh-air chamber, from which it passes through tempering heaters, air-washers, and reheaters into a double plenum chamber. From there it is driven by a motor fan into ducts with connections from the upper, or hot air, chamber and the lower, or tempered air, chamber. An individual duct runs to the base of each vertical flue communicating with the class-rooms. The mixing and volume dampers for each room are placed in the plenum chamber, under control of the janitor.

The chief advantage of this system is that the required volume and temperature demanded by each individual room may be had. Two sides of a building may be warmed by the sun while the other two sides are cooled by a cold wind. The occupants of rooms on these sides may require air ten degrees higher in temperature. The individual duct system allows them to get it. The direct radiators placed in the class-rooms cannot be depended upon to maintain the proper balance when a trunk system is used and air of the same temperature supplied to every room. The sunny side rooms need cooler air, and cannot get it by the trunk system. The individual duct system, moreover, is excellent in allowing monotony of atmospheric conditions to be avoided; a cooler or a warmer air may be had at will.

Mr. Kimball says: "The installation of the individual duct system increases the cost of the ventilating plant by two and one half per cent. in large, and five per cent. in small buildings." It is well worth it. He says automatic temperature-controlling systems may save ten to twenty per cent. of the annual fuel bill, and protect the class-rooms from excessive temperatures. By thermostatic devices in mild weather little or no steam is admitted to the class-room radiators, and cool air is delivered. In cold weather much steam is sent into the radiators and a warmer air delivered. Mr. Kimball says a thorough diffusion of the air through every portion of a class-room can be obtained by one or two fresh-air openings eight feet above the floor, with a single exhaust opening on the same side at the floor. The inlets should be directed towards the windows or be placed in the end walls as near as possible to the windows, and the outlet at the other end of the same wall near the floor. In churches and auditoriums the best results can be obtained by exhausting through mushroom openings near the floor and supplying air through openings in the walls or ceiling. The cool incoming air must be let in well above the occupants, so as not to cause unpleasant draughts.

In warm weather it is desirable to be able to reverse the current and send the cool air in at the floor. It is quite easy to arrange for this in the plant. Better still, both the in- and out-fans may be altered so as to impel into the building air which escapes through open doors and windows—an admirable plan. The cost of the plant such as sketched above is reckoned as about one and a halfpenny per cubic foot of space in the building. Only a proper combination of fresh-air supply and vitiated-air exhaust will afford a good ventilation in an auditorium. No occupant should be further than twenty-five feet from a fresh-air register or nearer than six feet to a vent register; the greater the number of both kinds of registers, the greater the satisfaction with the system. Direct radiators should be employed to balance loss of heat through windows and walls. They should be placed under windows, by doors, and along exterior walls. A large amount of radiation should be placed in vestibules to prevent annoying draughts.

In the temperate climate of Britain we can make do with an open fire and window system, which is intolerable in places where excessively low winter temperatures have to be faced. As, however, central heating is coming largely into use in public buildings, it is most necessary that it should be recognised that the true function of ventilation is to keep up the adequate loss of body heat and relieve the cutaneous sensations from monotony; that heating and ventilating systems must be kept separate and planned on the lines so well sketched out by Mr. Kimball; that architecture must be subservient to the demand for proper space, lighting, heating, and ventilation; and that intelligent, trained men (or women) are required to look after the systems of heating and ventilation, and work these so as adequately to cool, and avoid the monotony of, the occupants. L. H.

PROBLEMS OF MINE VALUATION.

THE State of Wisconsin has published a very interesting Bulletin under the title of "A Study of Methods of Mine Valuation and Assessment, with special reference to the Zinc Mines of South-western Wisconsin," by W. L. Uglow, which is well worthy of the attention of anyone concerned in the knotty problems of mine valuation. The Wisconsin Legislature has decided to impose a tax upon mineral property, which is to be valued on the same principle as is applied to all real estate in that State, namely, the "full value which could ordinarily be obtained therefor at private sale"; this phrase is not quite clear, but apparently means the value that could be realised under a sale from a willing seller to a willing purchaser. The difficulties that beset such a valuation in all circumstances are increased by the fact that in the majority of cases these mines are leased by the mining companies from the royalty owners, whilst the necessary capital is often borrowed from banks, so that three separate parties are interested in the mining property. It is interesting to note that the royalty payable to the owner varies from 5 to 15 per cent., averaging 10 per cent. on the gross receipts, the owner paying as a rule the real property tax upon the increased value of his land due to the fact that it is mineral-bearing, as well as an income tax upon the royalty that he receives.

Two points of general interest are to be found in the treatment of the royalty and of the interest upon the capital borrowed for working the mine, the author holding that neither of these can equitably be considered as an addition to working costs, but that both must be looked upon as coming wholly out of profits. Probably few will question this treatment of interest, but the royalty question appears much more open to discussion. Unfortunately most of the other points dealt with have only a local rather than a general interest, because the ore-bodies are all shallow, and the life of mines in this district is consequently only a short one, so that the methods of valuation here employed have only a limited application.

A number of methods of valuation are discussed in detail, namely: (1) The Finlay *ad valorem* method, which calculates the value of a mine as the present value of the average annual profits that may be expected to be obtained during the life of that mine, setting aside an annual sinking fund instalment, the total amount of all of which instalments, at the end of the estimated life of the mine, will amount to the present value. (2) The Arizona method, which takes the value of a mine for the purposes of taxation as represented by one-eighth of the gross production of the previous year, four times the net profit of the previous year and the value of the improvements. (3) The Colorado method, which takes the value as one-fourth of the value of the gross output of the preceding year, unless the net exceeds one-fourth of the gross, in which case the net output is taken to be the assessable value, except in the case of mines of the precious metals, where the value is taken to be half the value of the gross output plus the entire net output. (4) The Equated Income method, which takes the value as the present value of all future profits, these latter being taken as equal to the actual profits of the preceding year, excluding royalty, interest, and amortisation charges, assuming the same average length of life for all the mines of a district.

The author compares all these methods, and appears to decide in favour of the last-named. He is quite alive to the difficulties of the problem, and is also careful to point out the fact, too generally overlooked in the taxation of mines, that mining property is a wasting asset, and on this account ought not to be taxed on the same basis as ordinary real estate.

RECENT PROGRESS IN PYROMETRY.[1]

DURING the past five years, which is the period intended to be covered by the present paper, considerable advances have been made in the production of instruments for the measurement of high temperatures. Much valuable work in this direction has been carried out at the National Physical Laboratory in this country, and at the United States Bureau of Standards; and the manufacturers of pyrometers, chiefly in Britain and America, have introduced many new instruments for scientific and industrial purposes. Owing to the claims of atomic and molecular physics, the subject of pyrometry has not received that attention from physicists in general to which it is entitled by its industrial importance. The progress made in various directions may conveniently be considered under separate headings.

Standards of Temperature.

Various investigations of fixed points have confirmed, or at the most slightly modified, previously accepted figures. Up to the highest reading obtainable on the gas scale (1550° C.), the standards now in use appear to be well established; and beyond this the melting-point of platinum, as deduced by several different methods, is now accepted as 1755° C. This is a useful fixed point for the calibration of high-reading pyrometers.

The United States Bureau of Standards now issues materials of certified fixed points for the calibration of pyrometers. This procedure might with advantage be followed by our own National Physical Laboratory, so as to enable the indications of pyrometers to be checked from time to time by the user. If accompanied by instructions for use, a correct result would be ensured, and the danger of error resulting from the employment of materials of doubtful purity eliminated.

Thermo-electric Pyrometers.

One of the chief features of recent years has been the extension of the use of base-metal junctions in place of platinum and platinum alloys. Suitable base-metal couples develop a relatively high E.M.F., and enable a strong and cheap indicator to be used in place of the sensitive instrument required for couples of the platinum series. Most makers now furnish iron-constantan pyrometers, which may be used up to 900° C. R. W. Paul employs two iron-nickel alloys of different composition which will register 1000° C.; whilst the Foster Instrument Company use two nickel-chromium alloys, capable of reading to 1200° C. in continuous use, and to 1300° C. for occasional observations. For temperatures below 700° C. copper-constantan junctions are much used, as, for example, in pyrometers for superheated steam. Various other base-metal couples are in use.

The trustworthiness of base-metal junctions has been called into question by Kowalke (Transactions of the American Electrochemical Society, vols. xxiv. (1913) and xxvi. (1914)). Trials made on junctions of this type, as supplied by American makers, showed changes in calibration on heating for twenty-four hours ranging from 20° C. to 130° C., the higher figure being obtained at temperatures of 1000° C. The results showed the necessity of "ageing" the junctions by prolonged heating at the maximum temperature prior to calibration. Experience with British-made junctions shows that large errors of this nature do not occur, owing to a careful choice of materials and suitable treatment before calibrating.

[1] Abstract of a paper read before the Royal Society of Arts on May 12 by Mr. Chas. R. Darling.

C. C. Bidwell (*Physical Review*, June, 1914) has shown that a junction of carbon and graphite may be used to read temperatures as high as 2000° C. Previous heating to this temperature is necessary before calibrating in order to expel volatile matter, This junction gives promise of a valuable extension of the range of thermo-electric pyrometers, and may find industrial applications.

Materials for protecting junctions from the corrosive action of furnace gases have been added to by the introduction of alundum (oxide of aluminium), which melts at 2050° C.; a material known as "silit," which has a carborundum basis; and "silfrax," a substance resembling carborundum. All these materials are brittle, and therefore will not stand rough usage. As a protection for junctions used to read the temperature of molten brass or bronze, a tube of molybdenum has proved successful, as this metal is a good conductor of heat and is not acted on by the molten alloy.

Indicators for thermo-electric pyrometers have been improved in details by the various makers, resulting in greater trustworthiness. A new departure in commercial indicators has been made by the Leeds and Northrup Company of Philadelphia, who have adopted the potentiometer principle, formerly used only for accurate laboratory work. The connections are shown in Fig. 1, where B is a 2-volt accumulator, R_1 an

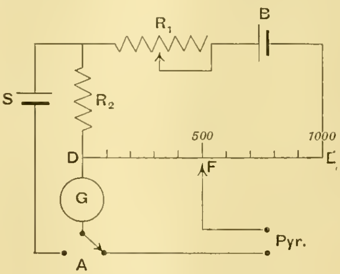

FIG. 1.—Potentiometer indicator.

adjustable resistance, R_2 a fixed resistance, DE a uniform stretched wire, S a standard cell, G a sensitive galvanometer, and A a switch. In order to maintain a steady fall of potential along DE, R_1 is adjusted so that on switching the standard cell into the circuit of the galvanometer, no deflection is observed. As the voltage of B falls off with use, this adjustment must be made from time to time. The pyrometer is connected to one terminal of the galvanometer and to a sliding contact F, which, in taking a reading, is moved along DE until no deflection is observed on G. From the known relation between temperature and E.M.F. for the junction used, DE may be graduated so as to read temperatures directly. The advantages of this arrangement are greater sensitiveness and independence of the resistance of the pyrometer and leads; the drawback, from an industrial standpoint, is that the readings are not automatic. Several methods for adapting an indicator for special ranges have been devised. In one form, due to the Cambridge Scientific Instrument Company, the indicator takes the place of the galvanometer G in Fig. 1, and by fixing the slider F at a given position—representing, say, 500°—the pointer of the indicator is prevented from moving until this temperature has been reached by the junction. The zero of the indicator is thus made to represent 500°, and by keeping F fixed, the whole of the scale may be utilised for reading from 500° upwards. A more open scale, with correspondingly closer readings, may thus be obtained; and by suitable adjustment of F the range covered may be varied as required. The same firm has also introduced a mechanical device for achieving the same object. In this a suspended-coil indicator is used, and by turning a torsion head a twist is imparted to the suspension, so that the pointer does not move over the scale until the temperature of the junction has reached an assigned figure. In the multi-range instrument made by R. W. Paul, the indicator takes the place of the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, a current may be made to pass through the indicator in an opposite direction to that produced by the heated junction; and only when this opposing current is overcome will the pointer begin to move over the scale. Resistances are provided which, when inserted in the arms of the bridge, disturb the balance so as to hold up the indicator until an assigned temperature—say 600°—is reached, when the whole scale becomes available for the selected range. By using two manganin and two copper resistances in the arms of the bridge, automatic correction is made for changes in the temperature of the cold junction. Thus, if the bridge were balanced at 20°, a current would flow through the indicator at any other temperature, as copper changes its resistance on heating or cooling, whilst manganin does not. The resistances are so chosen that the movement of the pointer caused by this current represents the increase or decrease in the temperature of the cold junction, and thus any errors due to this cause are eliminated.

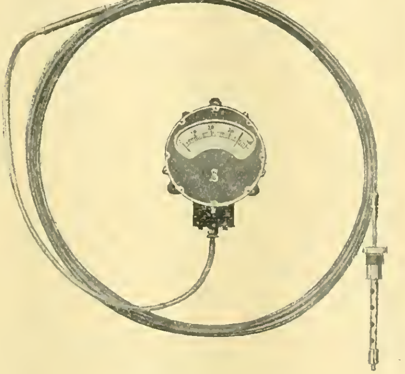

FIG. 2.—Pyrometer for superheated steam.

The regulation of the temperature of superheated steam on locomotives has given rise to the problem of producing an indicator practically unaffected by vibrations. This has been solved in various ways by different makers, and satisfactory instruments are now procurable for this purpose. Fig. 2 shows a pyrometer of this type made by Messrs. Siemens. Altogether, great progress has been made in this branch of pyrometry, particularly in the direction of greater accuracy.

Resistance Pyrometers.

No special change is to be recorded in connection with this class of instrument. The recent work of Sir William Crookes has shown that platinum is distinctly volatile above 1000° C., and this explains satisfactorily why resistance pyrometers were found to change their calibration when used above this temperature. For work at low or moderate temperatures the resistance pyrometer is much used on account of its superior accuracy, which, however, is only operative when the temperature to be measured is subject to precise control. It is now customary to employ thermo-electric pyrometers for the general run of metallurgical work, and to use a resistance pyrometer for very exact work, and for a workshop standard within its upper limit—1000° C.

The researches of Northrup on the resistance of molten metals (*Journal of the Franklin Institute*, January and March, 1914) suggest a possible extension of the range of resistance pyrometers by the use of a liquid element. Melted copper, for example, shows a uniform increase in resistance up to 1400° C., and this fact might be utilised in measuring temperatures if a suitable appliance were forthcoming. The decrease in the resistance of pyro-conductors with rise in temperature may possibly be utilised for resistance pyrometers. Alundum, for example, has a resistance of 6100 ohms per cm. cube at 1100° C., which falls to 190 ohms at 1000° C.—an average decrease of nearly 12 ohms per degree, which could easily be detected on a coarse instrument.

FIG. 3.—Foster's radiation pyrometer for molten metals.

Radiation Pyrometers.

A distinct improvement in these instruments has been the introduction of pivoted indicators in place of the suspended-coil type formerly in use. This has been made possible by the use of more sensitive junctions to receive the radiations. The Féry pyrometer has been modified by Whipple for determining the temperature of molten metals by mounting the pyrometer at the open end of a fireclay tube, so as to be permanently focussed on the closed end which is immersed in the metal. Foster uses a similar plan in connection with his fixed-focus pyrometer (Fig. 3) the end being closed by a salamander tube which is dipped into the metal. The telescope is pierced by a tube open at both ends, through which air may be

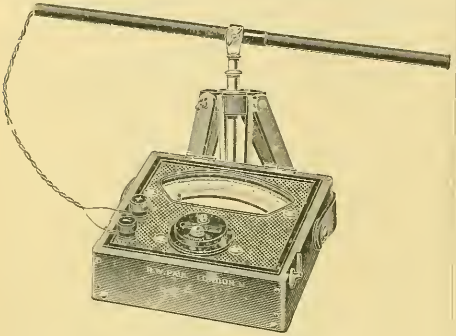

FIG. 4.—Paul's radiation pyrometer.

forced with the view of preventing fumes from reaching and corroding the mirror in the event of breakage of the immersion tube. Mr. R. W. Paul has introduced a radiation pyrometer in which the rays are received in a tube containing a polished cone, a junction at the apex receiving the radiations. This type of instrument, originally due to Thwing, gives the same reading at all distances within a given limit, and therefore requires no focussing. A unipivot galvanometer is used as indicator (Fig. 4). A high

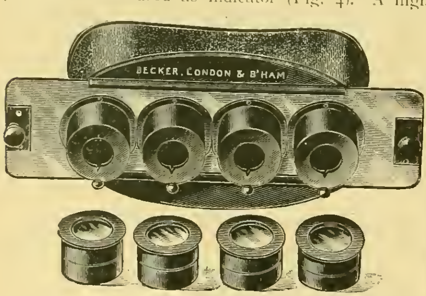

FIG. 5.—Heathcote's extinction pyrometer.

degree of accuracy has now been attained with radiation pyrometers, as is proved by tests on commercial instruments conducted at the National Physical Laboratory.

Optical Pyrometers.

The standard forms due to Féry, Wanner, and Holborn and Kurlbaum are now well established, and have been improved in details with a view to industrial use. A new type of optical pyrometer, based on the principle of colour extinction, has been introduced. In the form devised by Heathcote in the Research Laboratory of the Rudge-Whitworth Company, cells containing a liquid of the correct colour and density are used, so that the luminous rays from the heated object are extinguished at a given temperature. The instrument consists of an eye-shade (Fig. 5) in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, whilst the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is just visible in the lower pair, but invisible in the higher, the correct temperature has been attained. In another form a single cell is used, in which the depth of liquid may be adjusted until extinction occurs, and the temperature read off on a scale graduated in temperatures according to the depth.

FIG. 6.—Alder and Cochrane's extinction pyrometer.

Another form of extinction pyrometer has been designed by Alder and Cochrane (Patent No. 27,633, 1913), shown in Fig. 6. This consists of a small telescope, the rays through which are intercepted by a wedge of dark-coloured glass, which is moved until the sighted object just ceases to be visible. Temperatures are read from a scale which moves with the prism, and the range may be increased by inserting a piece of tinted glass in the eyepiece, and reading from a second scale prepared with the glass in position.

An important paper, embodying results which suggest a new type of optical pyrometer, was read by Paterson and Dudding before the Physical Society in March, 1915. It was shown that the temperature of many metallic substances could be measured by matching the colour against that of a black body until identical. A Lummer-Brodhun photometer was used, and the temperature of the black body varied until equality of hue was obtained. Filament lamps, with an ammeter and rheostat in the circuit, were thus matched, and became secondary standards, a given current corresponding to a known temperature. An optical pyrometer on these lines appears quite feasible.

FIG. 7.—Foster's recorder.

Lovibond has suggested an optical pyrometer in which a standard source of light is brought to equality of tint with the heated object by interposing tintometer glasses.

Recorders.

The value of temperature records is now so much recognised in the industries that all makers of pyrometers have given special attention to recorders, and have devised arrangements for registering the readings of several pyrometers simultaneously. For resistance pyrometers the well-known recorder of Callendar is much used, and the modern form of Roberts-Austen photographic recorder, made by the White Instrument Company, is of great service in accurate work with thermo-electric instruments. Of the more recent types Foster's recorder (Fig. 7) possesses an indicator pivoted horizontally, the pointer being vertical and moving across a circular chart rotating about its centre once in twenty-four hours. At short intervals a presser-bar is urged against the pointer, at the end of which is placed a capillary tube containing an inked wick. A mark is thus made on the chart corresponding to the position of the pointer; and as the lines radiating from the centre are divided into temperatures, a complete record, visible in its entirety, is made.

The thread recorder of the Cambridge Scientific Instrument Company has been improved in many details. One of the latest forms is shown in Fig. 8, in which two indicators are made to record on a single chart wound on a long drum rotated by clockwork. The presser-bar in this case pushes the pointer on to an inked thread, which touches and leaves an ink-dot on the graduated chart. By having two threads, coloured with different inks, and a mechanism which brings each thread in turn beneath the pointer, four simultaneous records may be taken, the pyrometers concerned being automatically switched on to the indicators in correct sequence.

A recorder in which the mechanism is driven by a motor has been introduced by the Leeds and Northrup Company, and is much used in the United States. R. W. Paul has also adopted the motor-drive in his new recorder (Fig. 9), which also embodies other novel features. The chart is made in the form of a continuous roll, lasting for 1000 hours, a large part of which is open to inspection through a window extension. The pointer is pressed periodically on to an inked ribbon, which touches the chart at a place where the latter is passing over a knife-edge, and hence a dot is produced. Change-gear for altering the speed may be inserted when desired, and duplicate records are secured by means of a second ribbon, of different colour, which may be made to alternate in position with the first ribbon beneath the pointer. When a resistance pyrometer is in use, a Harris indicator replaces the galvanometer, a new chart, divided to suit this indicator, being inserted.

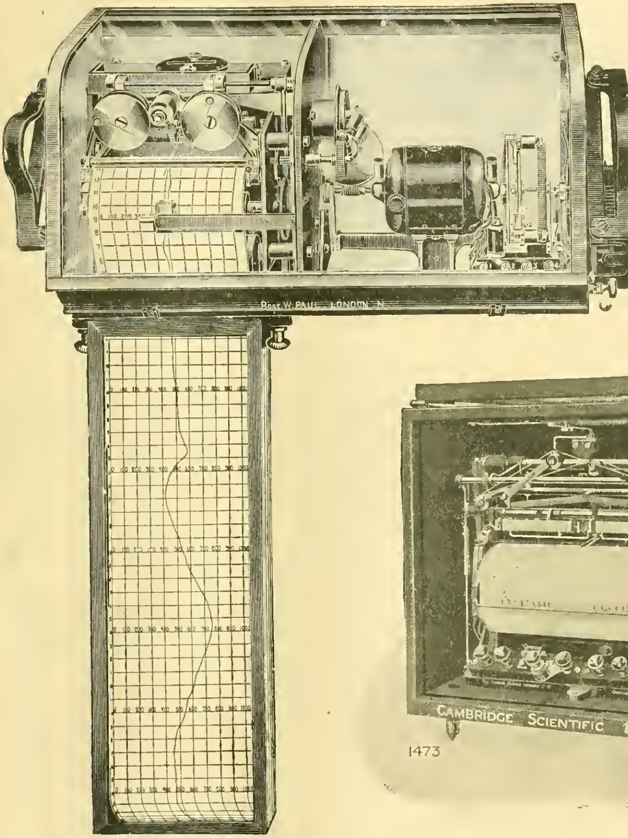

FIG. 9.—Paul's recorder.

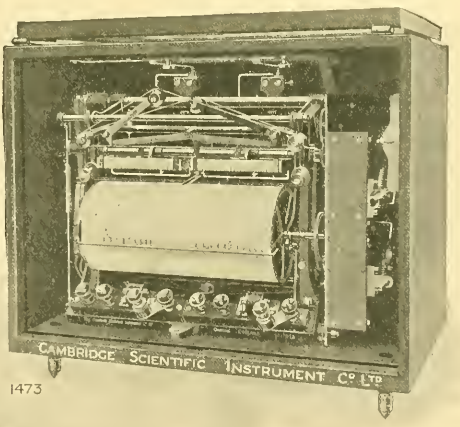

FIG. 8.—Double thread recorder.

In the latest form of Siemens' recorder, a long chart, visible over a considerable length through a window (Fig. 10) is also used. It is furnished with a

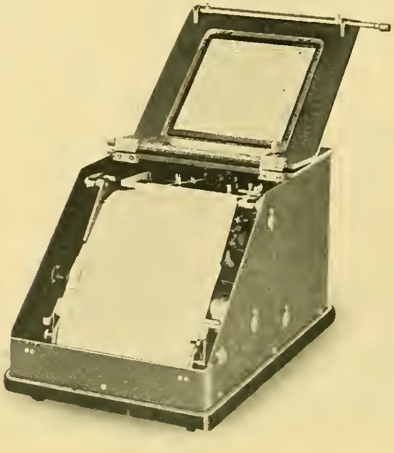

FIG. 10.—Siemens' recorder.

pivoted galvanometer, and the pointer is pressed on to an inked ribbon which touches the chart. Clockwork is used to actuate this recorder.

Conclusion.

The substantial advances made in this country in pyrometry during recent years may be cited as a useful guide as to how industry may be created and preserved. All the places at which pyrometers are made in Britain are under the direction of skilled scientific men, who are constantly devising new instruments and finding wider fields for their application. All are in close touch with the National Physical Laboratory, which has proved invaluable to them in securing uniformity of calibration, and in other ways. The result is a thriving and extending industry, not threatened by foreign competition, and not requiring artificial props to ensure its success.

MEMBERS OF SCIENTIFIC STAFFS OF UNIVERSITIES, COLLEGES, AND OTHER INSTITUTIONS ON ACTIVE SERVICE WITH H.M. FORCES.

SINCE the publication, in our issue of July 15, of the list of members of scientific staffs of universities, colleges, and other institutions on active service with H.M. Forces, we have received further lists which for various reasons did not reach us earlier. The names in the list subjoined are supplementary to those published in our register last week. In each case the list is limited to men who have been gazetted or have enlisted in one of the Services.

At the Meteorological Office permission to offer their services to the War Office or other Government department associated therewith for the period of the war has been given to Mr. G. I. Taylor, Schuster reader at Cambridge, and twelve members of the clerical and technical staff. Three of the attendants have left the service of the office to enlist. On the other hand, the professional and scientific staff has been increased for special duty in connection with meteorological field service by the addition of six meteorologists, three of whom are volunteers. More volunteers with professional qualifications in physics and mathematics are required for duty at the observatories.

BIRMINGHAM: UNIVERSITY.

Anderson, Dr. J. S., assistant lecturer in physics, Officers Training Corps.
Chadwick, P.M., assistant lecturer in civil engineering, 2nd Lieut. 2/2 Field Co., East Ang. Div. R.E.
Coates, J. E., special lecturer in physical chemistry, Lieut. R.N.V.R., attached to Air Department.
Johnson, G. E., assistant in agricultural zoology, 2nd Lieut. 15th (S.) Batt. Royal Warwick Regiment.
Jones, R. A., headmaster of training college for men, Major 15th (S.) Batt. Royal Warwick Regiment.
Lea, Dr. F. C., professor of civil engineering, 2nd Lieut. Officers Training Corps.
McCombie, Dr. Hamilton, assistant lecturer in chemistry, Lieut. 3/7 Worcester Regiment.
Panton, R. C., assistant lecturer in civil engineering, 2nd Lieut. 2nd Royal Dublin Fusiliers (wounded).
Thomas, W. Norman, lecturer in civil engineering, 2nd Lieut. 213th Fortress Co. R.E. (Warwicks).
Whitworth, E. S., assistant in training college for men, Lieut. 10th (S.) Batt. Royal Warwick Regt.
Wishart, W. G., assistant lecturer in machine design, Mechanical engineering, 2nd Lieut. Roy. Gar. Artil.

LEEDS: UNIVERSITY.

Atkin, W. R., assistant lecturer and demonstrator in leather industries, 2nd Lieut. 5th Batt. K.O.Y.L.I.
Birch, de B., professor of physiology, assistant director of medical services, 2/1st W.R. Division T.F.
Carr, W., assistant in textile department, driver Army Service Corps.
Comber, N. M., assistant lecturer in agricultural chemistry, Lieut. 8th Batt. Yorks.
Dyson, H. A., assistant in textile department, private 15th Batt. West Yorks.
Firth, A., mechanic in engineering department, Sergt. 7th Batt. West Yorks.
French, W. E., assistant lecturer and demonstrator in electrical engineering, Lieut. 17th Batt. W. Yorks.
Goode, C. W., milk tester in agriculture department, private T.F.
Hampshire, P., assistant in leather industries department, private R.A.M.C.
Jones, Ll. R., assistant lecturer in geography, Capt. 7th Batt. West Yorks.
Lee, E., assistant lecturer in agricultural botany, Lieut. 4th Batt. W. Riding (killed in action July 10).
Lloyd, W. G., demonstrator in physiology, Lieut. R.A.M.C.
Newby, A., assistant in textile department, private R.A.M.C.
Nuttall, J. M., demonstrator in physics, 2nd Lieut. 11th Batt. York and Lancasters.
Perkins, W. H., assistant lecturer and demonstrator in chemistry, Capt. O.C. Leeds Univ. O.T.C.
Potter, V. J., laboratory assistant in agriculture, private 15th Batt. West Yorks.
Priestley, J. H., professor of botany, Capt General Staff, Expeditionary Force.
Watts, A. E., mechanic in physics department, private 15th Batt. West Yorks.
Westmoreland, A., laboratory attendant in geology, bugler 7th Batt. West Yorks.
Whitaker, G., laboratory attendant, private R.A.M.C.
Woodhead, A. E., demonstrator in tinctorial chemistry and dyeing, Lieut. Leeds University O.T.C.

London: The Lister Institute.

Martin, Dr. C. J., director, Major A.A.M.S.
Petrie, Dr. G. F., assistant bacteriologist, Lieut. R.A.M.C.
Rowland, S., assistant bacteriologist, Major R.A.M.C.
Robison, Dr. R., assistant in biochemistry, Lieut. R.A.M.C.

Oxford: University.

Bourdillon, R. B., chemistry tutor, University College, Lieut. R.F.C. (S.R.).
Edmunds, P. J., demonstrator in physics, 2nd Lieut. Royal Engineers.
Hartley, H. B., chemistry tutor, Balliol College, Capt. 7th (S.) Batt. Leicestershire Regiment.
Schuster, E. H. J., biology fellow, New College, Lieut. Wessex Royal Garrison Artillery.
(Gill, W. B., demonstrator in physics, is Lieut. in the R.E. and not R.G.A., as stated last week.)

Sidmouth: The Hill Observatory.

Lockyer, Dr W. J. S., chief assistant, Lieut. R.N.V.R. (Air Service).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The following awards for research have been made at Emmanuel College:—Studentship of 120*l*., J. Conway Davies, for research on the baronial opposition to Edward II.; studentship of 100*l*., O. H. Hoexter, for an investigation of certain problems of currency; grants from the Research Studentship Fund, G. Matthai, Mackinnon student of the Royal Society, 50*l*. towards expenses while investigating the morphology of coral; J. Morrison, 60*l*. towards the expenses of investigation of the relative age of the intrusive rocks in the Shap district.

London.—Dr. F. A. Bainbridge has been appointed to the University chair of physiology, tenable at St. Bartholomew's Hospital Medical School. He has been professor of physiology at Durham since 1911.

The D.Sc. degree in organic chemistry has been granted to Mr. O. L. Brady, Royal College of Science, and the D.Sc. degree in engineering to Mr. Oscar Faber, an external student.

A new Board of Studies in Horticulture has been constituted, and regulations have been approved for diplomas in town-planning and civic architecture, and in town-planning and civic engineering.

Honorary bachelor degrees are to be conferred, in faculties other than medicine, on internal students who, on account of war service, have been prevented from completing the courses of study and examinations for their degrees.

Manchester.—Since the outbreak of the war 520 cadets have been granted commissions. Of these 210 were not members of the University, but were enrolled in the University Officers Training Corps, under the command of Major Sir Thomas Holland, the professor of geology. The officers of the contingent have specialised in such subjects as map reading, elementary field engineering, infantry tactics, military law, signalling, and army organisation. Cadet Sergt. Edgar has also given lectures on military history. Students in the department of economics have been working under the direction of Prof. Chapman, in collecting statistics for the Board of Trade. In the chemical, metallurgical, and engineering departments, both in the faculty of science and that of technology, important work is being done for the War Office and for the Admiralty, and a considerable number of the members of the staff and students are engaged in scientific investigations and tests for the Government. The women members of the staff have organised among the women students two Red Cross detachments and other groups offering special social service.

Science announces that Mr. J. J. Hill has given 25,000*l*. to Harvard University to endow a professorship of transportation in the graduate school of business administration. We learn from the same source that a trust fund of 20,000*l*., the proceeds of which are to be divided between the William Pepper Clinical Laboratory of Medicine and the Latin and Greek department, is bequeathed to the University of Pennsylvania under the will of Samuel Dickson, of Philadelphia.

The trustees of the Beit Fellowships for Scientific Research, which were founded and endowed two years ago by Mr. Otto Beit, in order to promote the advancement of science by means of research, have recently elected to fellowships the following:—Mr. W. B. Haines, of Leytonstone, Mr. C. K. Ingold, of Chiswick; and Mr. H. N. Walsh, of Cork. Mr. Haines studied at University College, London, from 1907 to 1913, at the University of Göttingen, 1913–14, and has since been at the Imperial College. Mr. Ingold was an exhibitioner of the University of London in 1912, and a royal scholar in 1913; from 1911 to 1913 he was at the Hartley University College, Southampton. Mr. Walsh received his education in Ireland. He was a scholar, medallist, and prizeman at University College, Cork, and is now assistant to Prof. Alexander. The three fellows will carry on their respective researches in the Imperial College of Science and Technology.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, July 12.—M. Ed. Perrier in the chair.—J. **Boussinesq**: Reflections on the principles of the dynamics of Aristotle and their agreement with experiment in the case of uniform phenomena.—B. **Boulyguine**: The representation of an integral number by a sum of squares.—J. **Deprat**: The mode of formation of two Japanese volcanic centres, Aso-San and Asama-Yama, compared with the volcanic centres of ancient geological periods. The structure of the volcano of Aso-San is exactly comparable with the great volcanic centre of Anglona, in Sardinia. Asama-Yama has another type of structure, and in its mode of working recalls Mt. Pelée. It compares exactly with the trachyte dome of Monte Ferru, in Sardinia.—D. **Eginitis**: The geological phenomena observed during the two last earthquakes at Leucade and Ithaca. The dislocations due to seismic phenomena can be traced historically from the first century right up to the present time, and represent a continuation of the great geological phenomena which have separated the island of Leucade from the mainland of Greece. There is no conclusive evidence of volcanic manifestations, the appearance of clouds on the Leucade mountains, observed during the last earthquake, being most probably due to dust arising from the fall of rocks.—F. **Bordas** and S. **Bruère**: Contribution to the study of the phenomena of putrefaction. It is the custom in France, in the country, to bury small animals which have died on the farm in the manure heap. It is shown that complete resolution of the organic elements of the body takes place very rapidly under these conditions, the organisms present in the manure assisting the rapidity of the decomposition.—Marc **Tiffeneau**: Comparison of the various adrenalines and their homologues, measured by their action upon the arterial pressure in a dog under the influence of atropine. The dogs used in these experiments were placed under the influence of chloral and atropine, and the advantages of this method are described. Lævo-rotatory adrenaline, either natural or synthetic, was proved to be from 15 to 20 times more active than its dextrorotatory isomer. This is in accordance with the fact already known, that the synthetic racemic compound has about half the activity of the natural adrenaline.—P. **Petit**: Some observations on malt amylase. Extracts with water or dilute alcohol contain a large proportion of foreign material and do not keep. By the use of aqueous acetone in the manner described a solution of diastase can be prepared the activity of which remains constant for several weeks. This solution can be precipitated by a mixture of ether and acetone, giving a disastase which can be dried, and which is of high activity.—Em. **Bourquelot**, M. **Bridel**, and A. **Aubry**: Researches on the preparation of glucosides from glycerol with the aid of α-glucosidase.

CAPE TOWN.

Royal Society of South Africa, June 16.—Dr. L. Péringuey, president, in the chair.—R. W. **Shufeldt**: Osteology of Palæornis with other notes on the genus. A description is given of one of the most abundant parrots of India—*Palaeornis torquatus*, or the ring-parrot—so named for the reason that in the adult a ring or collar forms a part of the plumage of the neck.—Miss A. V. **Duthie**: Note on apparent apogamy in *Pterygodium newdigatae*. This paper deals with a cleistogamous variety of the South African orchid, *Pterygodium newdigatae*, and is of special interest because cleistogamy, rare enough among orchids, appears here to be accompanied by apogamy. Sections of the ovary and column at various stages of development show no trace of pollen tubes. The gland-like "pollen masses," which remain permanently embedded in the tissue of the rostellum arms, do not appear to develop beyond the mother cell stage.—F. **Eyles**: A record of plants collected in Southern Rhodesia. This record includes representatives of 160 families, 869 genera, and 2397 species, besides 112 varieties. The flowering plants are arranged on Engler's system as set out in the "Genera Siphonogamarum" of Dr. C. G. de Dalla Torre and Dr. H. Harms, 1900–1907. The ferns and fern allies are arranged in accordance with the system of Engler and Prantl, as shown in the check list of flowering plants and ferns of the Transvaal and Swaziland by J. Burtt-Davy and Mrs. Pott, 1911. With regard to the lower cryptogams, the arrangement is that of Strasburger's "Text-book of Botany," 1903.—J. S. v. d. **Lingen**: Description of (1) a simple apparatus for finding "g"; (2) a simple apparatus for standardising a given vibrator.

BOOKS RECEIVED.

Prehistoric Society of East Anglia. Report on the Excavations at Grime's Graves, Weeting, Norfolk. March–May, 1914. Pp. 254+plates. (London: H. K. Lewis.) 5*s*. net.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1914. Pp. xii+147. (Kristiania: Gröndahl and Sön.)

Nedboriagttagelser i Norge utgit av det Norske Meteorologiske Institut. Aargang xx., 1914. (Kristiania: Aschehoug and Co.) 3.00 kronen.

Canada. Department of Mines. Mines Branch. Petroleum and Natural Gas Resources of Canada. Vol. i. By F. G. Clapp and others. Pp. xviii+378. (Ottawa: Government Printing Bureau.)

Lessons in Elementary Physiology. By T. H. Huxley. Enlarged and revised edition. Pp. xxiv+604. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

Steam Power. By Prof. W. E. Dalby. Pp. xvi+760. (London: E. Arnold.) 21*s*. net.

The Book of France. Edited by Winifred Stephens. Pp. xvi+272. (London: Macmillan and Co., Ltd.; Paris: E. Champion.) 5*s*. net.

Agricultural Laboratory Manual. Soils. By Prof. E. S. Sell. Pp. iv+40. (Boston and London: Ginn and Co.) 1*s*. 6*d*.

Aids to the Analysis and Assay of Ores, Metals, Fuels, etc. By J. J. Morgan. Second edition. Pp. viii+138. (London: Baillière, Tindall and Cox.) 3*s*. net.

The Science of Mechanics. A Critical and Historical Account of its Development. By Prof. E. Mach. Translated by P. E. B. Jourdain. Pp. xiv+106. (Chicago and London: The Open Court Publishing Co.) 2*s*. 6*d*. net.

Contributions to the Founding of the Theory of Transfinite Numbers. By G. Cantor. Translated by P. E. B. Jourdain. Pp. ix+211. (Chicago and London: The Open Court Publishing Co.) 3*s*. 6*d*. net.

Selections from the Scottish Philosophy of Common Sense. Edited by G. A. Johnston. Pp. vii+267. (Chicago and London: The Open Court Publishing Co.) 3*s*. 6*d*. net.

The House Fly: a Slayer of Men. By F. W. Fitzsimons. Pp. vi+89. (London: Longmans, Green and Co., Ltd.) 1*s*. net.

The British Mycological Society. Transactions for the Season 1914. Vol. v., part i. May. Pp. xii+186. (Worcester: E. Baylis and Son.) 10*s*. 6*d*.

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THURSDAY, JULY 29, 1915.

THE STUDY OF METALS AND ALLOYS.

An Introduction to the Study of Physical Metallurgy. By Dr. W. Rosenhain. Pp. xxii+368. (London: Constable and Co., Ltd., 1914.) Price 10*s*. 6*d*. net.

IT may be doubted whether the title of this book has been happily chosen. So far as its subject matter is concerned, with the exception of one chapter on the mechanical testing of metals, it has hitherto been described by the term "Metallography." The latter, which dates back to 1721, was originally used to signify the description of metals and their properties. In this sense it is certainly obsolete, but it was re-introduced in 1892 to describe the microscopic structure of metals and alloys, since when, as Dr. Desch points out in his text-book, "Metallography" (Longmans and Co.), "it has been generally accepted, gradually receiving an extension of meaning to include investigations by other than microscopic means." Dr. Rosenhain, in using the term physical metallurgy to describe such subject matter, writes:—"The scope of physical metallurgy is an exceedingly wide one, and one which brings it well over the borderland of several sister sciences—such as chemistry on the one side, physics on another, and that branch of knowledge generally known as 'strength of materials' in yet another direction. Besides these, crystallography bears largely on our subject." This being the case, it appears to the writer that "Metallography" is the more appropriate title, as being both more accurate, more inclusive, and better suited to a rapidly growing science. Nowhere in this book, so far as can be seen, does the author attempt to bring the terms "Physical Metallurgy" and "Metallography" into relation with each other, and there are places where he appears to use them as interchangeable expressions.

The book is divided into two parts. The first deals with the structure and constitution of metals and alloys, the second with the properties of metals as related to their structure and constitution. As the title indicates, it is an introduction to a particular type of study, but it also serves as an introduction to a metallurgical series which is in course of publication under the author's editorship. This being so, he writes:—"The treatment of the whole subject in the present work has been intentionally kept somewhat general, the object of the author being to awaken interest and to stimulate thought and ideas rather than to communicate a great mass of detailed data." The author has certainly achieved his purpose. He has written an interesting book full of suggestions, and he has presented his subject with remarkable fairness, and due acknowledgment to other workers. Chapter xi, dealing with the effect of strain on the structure of metals, a field of investigation in which he has been one of the pioneers, is one of the best pieces of writing extant on this subject.

No one acquainted with Dr. Rosenhain's technique will be surprised to hear that the photographic illustrations are excellent, but some of the diagrams are far from satisfactory. In describing the copper-aluminium equilibrium, certain letters are used in the text which are obviously meant to correspond to similar letters in the constitutional diagram, but which are conspicuous there only by their absence. It is somewhat surprising to come across the statement (page 110):—"No investigation of the constitution of a system of alloys can be regarded as really complete until a study of electrical conductivities and temperature coefficients has been carried out." Very few systems are composed of alloys which are ductile from one end of the series to the other. In the great majority of cases, as the author himself points out, there exists in the middle regions of the binary series a zone of brittleness and weakness where, not only can the alloys not be drawn into wires, but where they cannot even be turned in a lathe. Determinations of electrical conductivity would in such cases have to be made on rods cast to shape, and owing to their proneness to contain cavities or blow-holes, they would not be suitable for exact work and therefore as evidence in questions of constitution. Microscopical and thermal analyses still remain the fundamental methods of investigation in the determination of the constitution of alloys, and in most cases they are sufficient.

The author regards as anomalous and as requiring further research (page 305) the fact that α brasses cannot as a rule be hot-rolled (although they can be cold-rolled) whereas $\alpha+\beta$ brasses can be hot-rolled even though β is considerably harder than α. He mentions, however (footnote to page 145), that he has recently seen an α brass successfully hot-rolled, and suggests therefore that "the hot shortness of the brasses may not be an inherent property of the alloys." In reality the explanation is quite simple. Lead is an invariable constituent of all commercial brasses. It is almost insoluble in α brass and the red shortness of this material is due to the presence of films of liquid lead among the solid α crystals. If, however, α brass is made from copper and zinc free from lead it can be hot-rolled without difficulty. The

 Z

β constituent, on the other hand, dissolves lead appreciably above 470° C., and hence at the temperature of hot rolling the $\alpha+\beta$ alloys do not contain liquid lead and are not hot short.

H. C. H. Carpenter.

PENCIL AND PEN IN SYSTEMATIC ZOOLOGY.

(1) *Catalogue of the Amatidae and Arctiadae (Nolinae and Lithosianae) in the collection of the British Museum.* By Sir G. F. Hampson. Plates i–xli. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 33*s*. 6*d*. net.

(2) *A Revision of the Ichneumonidæ based on the Collection in the British Museum (Natural History), with Descriptions of New Genera and Species. Part iv., Tribes Joppides, Banchides, and Alomyides.* By C. Morley. Pp. x+167. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 6*s*.

(3) *The Syrphidae of the Ethiopian Region based on Material in the collection of the British Museum (Natural History), with descriptions of New Genera and Species.* By Prof. M. Bezzi. Pp. 146. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 6*s*.

(4) *British Museum (Natural History): British Antarctic ("Terra Nova") Expedition,* 1910. *Natural History Report. Zoology, vol. i., No.* 3, *Cetacea.* By D. G. Lillie. Pp. 85–124. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 7*s*. 6*d*.

(5) *Catalogue of the Fresh-Water Fishes of Africa in the British Museum (Natural History).* Vol. iii. By Dr. G. A. Boulenger. Pp. xii+526. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 2*l*. 5*s*.

(6) *The Fauna of British India, including Ceylon and Burma. Mollusca (Fresh-water Gastropoda and Pelecypoda).* By H. B. Preston. Pp. xix+244. (London: Taylor and Francis, 1915.) Price 10*s*.

(7) *British Museum (Natural History): British Antarctic ("Terra Nova") Expedition,* 1910. *Natural History Report. Zoology. Vol. ii., No.* 4, *Mollusca. Part i., Gastropoda Prosobranchia, Scaphopoda, and Pelecypoda.* By E. A. Smith. Pp. 61–112. (London: British Museum (Natural History) and Longmans, Green and Co., 1915.) Price 4*s*.

MODERN researches provide a well-trained army of naturalists with an almost overwhelming supply of material. A vast literature has to be examined to make sure that species apparently new to science have not been already described. Assistance is afforded by elaborate monographs of separate groups, such as Sir George Hampson's monumental catalogue of the Lepidoptera Phalænæ, in thirteen volumes. But there is no finality in these obliging auxiliaries, for, as usual, while Sir George's catalogue was being issued between 1898 and 1913 other workers were industriously making it incomplete, so that already the monographer has had to provide a supplement, beginning with a first volume of nearly 900 pages. Some complication in descriptive work is also unavoidable, when several independent expeditions make their way to the same goal, as within the last few years has been the case with ships visiting the antarctic region and exploring the marine fauna at stations along the route.

To meet the initial difficulties in investigation of species nothing is more time-saving to the naturalist than trustworthy illustrations of the group he is studying. Faithful colouring is in some parts of the animal kingdom an additional boon of great value. The drawback is the initial costliness of production, and, consequent upon this, prohibitive prices forcing the student in many instances to rely upon borrowed copies or occasional visits to distant libraries. During the last two centuries the extreme desirability of well-illustrated zoology has been evidently fully appreciated though very variously provided for. Among individual efforts none is more remarkable than that of the Dutch physician, Albert Seba, who in the first half of the eighteenth century must have spent a fortune over the production of his 450 large folio plates, many of which are double. Latreille in 1830 commended them as excellent, though he condemned the "Accurata Descriptio" as worthless. At the same period Cuvier and his colleagues paid the plates an extraordinary compliment by re-issuing the whole mass with a brief revision under the editorship of Guérin. Just then, also, the French Government was issuing 198 rather larger and much more refined plates, illustrating the voyage of the *Astrolabe*, to which Mr. Edgar A. Smith makes several references in his recent memoir.

As the accomplished authors whose works are mentioned at the head of this notice must all be acutely conscious of the expediency of doing unto others as they would that others should do unto them, it is interesting to compare the different ways in which they have dealt with the supply of illustration. (1) The forty-one plates of Hampson's supplementary volume are filled with delicately coloured representations seemingly of all the species recorded in the supplement which have not been previously figured. An economy now commonly practised, and no doubt very necessary, shows the wings only of one side. This should redeem from heartless ridicule the proverbial pig with only one ear, but by depriving the moth or butterfly of its bilateral symmetry it makes it somewhat of an artistic failure. A carcinologist is apt to find variation in colour-marking very untrustworthy for specific distinction. The entomologist, on the other hand, appears to rely upon it with considerable confidence.

(2) This is further exemplified in Mr. Claude Morley's revision of the Ichneumonidæ, although, so far as illustration goes, that work is in striking contrast to the generous treatment of the Lepidoptera. For Part iv., with more than forty new species, has only a single figure. This one example, however, is furnished with the full complement of wings, antennæ, and hexopodal appurtenances, and is to some extent suggestive of the "remarkable grace and beauty, combining delicacy of outline with both fine and brilliant, not infrequently metallic, coloration," which Mr. Morley claims for the objects of his study. It is rather unfortunate that the plate unmistakably shows an insect in which the wings have each a brown band and brown apex, while the *Joppa nominator*, Fabricius, which it is said to represent, is described by Fabricius as having "alis omnibus fascia apiceque nigris" ("Ent. Sys.," vol. ii., p. 158, 1793). Mr. Morley reveals without explaining the discrepancy.

(3) Prof. Bezzi's work on the African Diptera of the family Syrphidæ is less abstemious in the matter of illustrations, and, besides a useful explanatory diagram, furnishes very full and important keys for the discrimination of the genera and species. Mr. C. J. Gahan's verdict may well be accepted that the present treatise "greatly advances our knowledge" of the group. There are said to be about 2300 described species, and the difficulty of dealing with them is attested by E. Brunetti, who some years ago said of the genus *Syrphus*, "this genus I do not touch upon at present in view of the large number of supposed species described from Oriental regions, and their close affinities" ("Records Ind. Mus.," vol. ii., p. 57, 1908).

(4) Passing now from the air to the water, it will be found that Mr. D. G. Lillie gives as many illustrations of the Cetacea as could be expected from his opportunities, seeing that he starts with the acknowledgment that the *Terra Nova* "did not succeed in capturing any specimens of this group." He mentions the belief of whalers that humpback whales rub themselves against rocks to get rid of the Balanid *Coronulae*. To this opinion there are two objections: one, that with the Coronula once fixed in the whale's soft skin, more irritation would probably be caused by rubbing it off than by leaving it alone; the other, that the soft-stalked Lepadid Conchoderma so curiously and prominently planted on the Balanid implies that the Coronula is a place of exceptional security.

(5) Dr. G. A. Boulenger's fine catalogue of fresh-water fishes of Africa is now continued in a third volume, with promise of a fourth. The species described are 394, and there are 351 text-figures, 45 of them species not in the British Museum collection. It is pleasant to observe that for the *Muraena anguilla* of Linnæus Dr. Boulenger accepts the name *Anguilla vulgaris*, Turton, in place of the barbarous tautology in which some authorities delight. In dealing with the Cichlidæ, which occupy three-fourths of the present volume, he is forced to admit that Nature is sometimes very ill-natured to the conscientious systematist, spoiling the best-laid schemes of classification by a very inconvenient interlacing of characters. This appearance, however, of what our distant cousins call *Schadenfreude* is not due to a pure delight in mischief, but is the simple result of that universal consanguinity in which the sincere evolutionist is bound to believe. In a synopsis of 41 genera, and a further synopsis of a genus with 94 species, there are pretty sure to be some entanglements. To lovers of odd fishes, *Psettus sebae* may be commended, with its "body deeper than long," a species figured life-size by Seba as *Chaetodon quadratus*. The mouth of *Corematodus shiranus*, Boulenger, must be useful for hygienic mastication, but disagreeable to its prey, as its massive jaws are fitted with "extremely broad bands of innumerable minute club-shaped teeth."

(6) In Mr. Preston's treatise, "wherever possible, illustrations of hitherto unfigured species have been given." The author regrets that he "can, in most instances, only deal with the shells of the species quoted," material for anatomical work not being available. But in his Introduction he is able to give several interesting bionomic notes, and for the anatomy of one species, *Mulleria dalyi*, Smith, he has a sad satisfaction in quoting largely "from the late Mr. Martin F. Woodward's invaluable Paper on the subject." In some of his references Mr. Preston leaves the student rather in the dark. Thus he cites:—"*Theodoxis*, de Montfort, Conch. Syst., ii., 1810, p. 350; *Neritina*, Lamarck, 1822 [*Neritine*, 1809]. Type, *T. lutetianus*, de Montfort (*fluviatilis*, Linn.)", without saying whether Neritine is French or Latin, or where it is to be found, and without showing that p. 350 in de Montfort is only a plate,

while the description of genus and species on p. 351 gives the authoritative spelling in the name *Theodoxus lutetianus.*

(7) The numerous new species described in Mr. E. A. Smith's treatise are illustrated in two excellent plates. Mr. Smith's mastery of the subject almost forbids criticism, but may still excuse inquiry in regard to his use of the generic names Rissoia and Panope. In the "Discovery" Gastropoda, 1907, he transferred without explanation his *Rissoa adarensis* to Rissoia. Under *Rissoia adarensis* (Smith) he now adds a note: "A synonym of *Rissoa* is *Apanthausa,* Gistel ('Naturgesch. Thierreichs,' 1848, p. x)," without explaining what is the relationship of Apanthausa to Rissoia. In 1850, Gistel in the "Handbuch der Naturgeschichte," p. 554, declares that Rissoa must be changed (though he does not say why) into his Anatasia, the date of which is given by Scudder as 1848. Neither Gistel in 1850 nor Scudder later on makes any mention of Apanthausa. A further perplexity is caused by Mr. Smith's change of *Panopaea zelandica,* Quoy and Gaimard, into *Panope zelandica,* without any reference to show that Panope, as the name of a molluscan genus, antedates its use in 1813 by Leach for a genus of Crustacea. Les "Panopes," Lamarck, Ann. du Mus. Paris, vol. x., p. 394, 1807, is a French term.

T. R. R. STEBBING.

CHIEFLY MONGIAN GEOMETRY.

(1) *Descriptive Geometry for Students in Engineering Science and Architecture. A Carefully Graded Course of Instruction.* By Prof. H. F. Armstrong. Pp. vi+125. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8*s.* 6*d.* net.

(2) *Geometry of Building Construction: Second Year Course.* By F. E. Drury. Pp. xii+226. (London: G. Routledge and Sons, Ltd., 1915.) Price 3*s.* net.

(3) *Practical Science and Mathematics.* By E. J. Edwards and M. J. Tickle. Pp. viii+175. (London: G. Routledge and Sons, Ltd., 1915.) Price 1*s.* 6*d.* net.

(1) THE geometry of Monge, in which three-dimensional bodies are represented by plan and elevation, is one of the most educative branches of mathematics; and yet it is taught in this country only as a technical subject for engineering and architectural purposes. The secondary school is unaware of its existence. Hence the pleasure with which we find a Canadian writer on the subject reckoning that his book will be used in high schools. Let us hope that the good traditions of Canada will be adopted by England. The book covers the usual ground. The problems are based on the usual conventional figures. The book is beautifully got up, the text and figures both being admirable.

(2) This book is also on Mongian geometry. In place, however, of the conventional subjects, it treats real problems of building construction throughout. It is, in fact, intended as a builder's text-book. Just on that account it forms a suitable book for any student of Mongian geometry. The propositions of the subject presented in the abstract are too difficult for the majority of students. The treatment of the propositions as inductions from concrete problems makes them much easier to grasp and to retain. This distinction is realised by the author and forms the basis of the book, as indeed it does of the whole series. The book is certain to have a wide sphere of usefulness.

(3) This book also belongs to the excellent series edited by Mr. Udny Yule. It is concise and clear, the style simple and direct. The inductive method is wisely followed, a number of particular cases being followed by a generalised statement. It is a useful book, and avoids confusing the mind by excess of abstract reasoning. There is a generous use of graphs, and the only fault we find is the failure to emphasise the fact that the "algebraic law of the relation between two quantities" $y=ax+b$ is only one among many possibilities.

ELECTRICAL ENGINEERING TEXT-BOOKS.

(1) *A Treatise on the Theory of Alternating Currents.* By Dr. A. Russell. Vol i. Second Edition. Pp. xiv+534. (Cambridge: At the University Press, 1914.) Price 15*s.* net.

(2) *Electrical Engineering.* By Dr. T. C. Baillie. Vol. i. Introductory. Pp. vii+236. (Cambridge: At the University Press, 1915). Price 5*s.* net.

(3) *Electrical Instruments in Theory and Practice.* By W. H. F. Murdoch and U. A. Oschwald. Pp. viii+366. (London: Whittaker and Co., 1915.) Price 10*s.* 6*d.* net.

(4) *Alternating-Current Electricity and its Applications to Industry.* First Course. By W. H. Timbie and Prof. H. H. Higbie. Pp. x+534. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8*s.* 6*d.* net.

(1) A NEW edition of Dr. Russell's book will be welcomed both by physicists and electrical engineers, particularly by those who

have to teach advanced students. The addition of greatest interest to electrical engineers is the chapter dealing with the theory of coupled electrical circuits. This subject is now of great importance in wireless telegraphy and a simple and complete statement of the theory, such as that worked out by Prof. Fleming or that contained here, is of great value. The tables for determining high-frequency resistance and for estimating the inductance of coils and for calculating the effective capacity of a long antenna should also be of importance to radiotelegraph engineers. It is impossible, in a short notice, to describe adequately the vast field of theoretical work that the book covers, or to do justice to the masterly treatment of the many problems with which it deals. The book has already taken its place as a standard work on alternating current theory, and the additions made in this new edition will tend to establish it more firmly in the position it has already attained.

(2) The opening chapter of Dr. Baillie's book on electrical engineering contains a useful summary of the pioneer work on which the modern practice of electrical engineering rests. Brief reference is made to the work of Volta, Galvani, Siemens, Ampère, Clerk-Maxwell and many others. At the present time it is perhaps of interest to note that among those whose names are household words in electrical science, only two, those of Siemens and Hertz, are of Teutonic origin. The following chapters deal with the ordinary phenomena of electrical conduction, the measurement of resistance power and current, about which all elementary students in electrical engineering have to learn, together with chapters on batteries and the electric light.

Special mention may be made of chapter vii, which deals extremely well with the potentiometer and its uses, and to the chapter on batteries, which is exceptionally clear and good. The book is sufficiently elaborate to meet the needs of students taking a first year course in a technical college Some doubt may be expressed as to the value of such figures as 18, 19, 20, 21, 24, 25, 26, which show the outer cases of instruments. This, however, is a minor defect; the illustrations do not detract from the value of the book, they merely add unnecessarily to its bulk. As a text-book for elementary courses in electrical engineering it should fulfil a useful purpose, a result which is greatly assisted by the 125 examples, to be worked by the students, which are given at the ends of the chapters.

(3) The book by Messrs. Murdoch and Oschwald on electrical instruments is a welcome attempt to discuss the design and construction of electrical instruments from the broadest point of view. The theory of their action and their mechanism is clearly laid down. The opening chapter contains a brief summary of the history of exact measurement together with a short account of some absolute determinations of the fundamental electrical quantities. In this connection it is interesting to note that so recently as 1881 Kelvin and Bottomley stated that "the most accurate method of measuring candle power was by comparing the shadows of a pencil illuminated by the two sources." The summary shows clearly how the development of electrical instrument construction is related to the practical needs of the industry.

In an interesting chapter on damping, the general theory is laid down and discussed in connection with the instruments in which it forms an essential feature, the Grassot fluxmeter being, of course, the outstanding example. The following chapters describe the ordinary form of moving coil ammeter, electrostatic and current voltmeters, hot wire instruments, dynamometer type instruments, and energy meters. In the chapter on magnetic testing a suggestion is made to resuscitate the old magnetometer method of testing with weak fields. This method is an admirable one under suitable conditions, but in a laboratory within range of an electric tramway or railway, or even of electric light mains, it is nearly useless. There are numerous figures and results given throughout the book which have been obtained from the authors' own requirements, which are of value as independent testimony to the accuracy of the apparatus with which they have been made. The book should be a useful work of reference for those who are engaged in the manufacture of electrical instruments and in electrical testing.

(4) The book on alternating current electricity and its application to industry by W. H. Timbie and H. H. Higbie is an attempt to simplify the teaching of alternating current technology for engineering students. The teaching of this subject has advanced with great strides since the time, some twenty years ago, when the study of alternating currents was regarded as a branch of applied mathematics, to be taken after an elaborate introductory mathematical training. Alternating current work should form part of a normal second year course for all engineering students, and this book is one which should be most useful as a text-book for helping in the teaching of this subject during the early stages. The hydraulic analogies in many cases are ingenious and enlightening, and explain the apparent incon-

sistencies met with in alternating current work. The only serious criticism that may be offered is that it attempts rather too much. For example, in Problem 55, on p. 275, the student is asked to calculate the self-induction of a long three-phase transmission line, and in the next question to calculate the corresponding reactance. He might be led to expect that this result would give him the drop of the line, whereas it does not, because the mutual induction between the lines and the difference in phase between the currents in the lines are not taken into account. One might also be inclined to criticise the amount of space devoted to the subject of armature windings for alternators. This is defended in the preface, as a useful mode of teaching polyphase current technology. In practice an oscillograph demonstration of phase differences would be much more illuminating. The order of taking up the subject, too, strikes one as rather unnatural. It is surely a mistake to leave out any reference to the physical nature of self-induction and capacity until reactance has been studied.

The argument from the concrete example to the abstract theory is much used in America and elsewhere, and possibly has advantages for engineering students; the danger of it is that the student, when he can calculate what he wants to calculate about his machines, will often never bother to find out the reasons for his methods; he will become a rule-of-thumb man instead of a scientifically trained engineer. The danger is a very real one, which must be combated if engineering students are to become useful in engineering development work, the work for which engineering colleges should strive to train their men. In spite of minor defects, the book may be recommended as a satisfactory text-book for students of electrical engineering in the early stages of their training.

OUR BOOKSHELF.

The Electric Dry Pile. By C. E. Benham. Pp. 37. (London: P. Marshall and Co., 1915.) Price 1*s.* net.

THIS little book is a reprint of articles published in the *English Mechanic* during the present year. The dry pile, built up in the same way as Volta's moist pile, was the invention of Jean André De Luc, who first described it in *Nicholson's Journal,* 1810. It was constructed by piling up in a glass tube a series of paper discs, coated on one side with silver leaf and on the other with thin leaves of zinc. A continual difference of potential was found to exist between the terminals. Modifications were introduced by various workers, notably Zamboni and Singer. The latter devised the form of apparatus now in the Clarendon Laboratory of the Oxford University Museum. This is arranged to ring a small bell, and its period of activity now extends to seventy-five years. Mr. Benham gives detailed instructions for setting up a dry pile of 2000 pairs, and describes a number of interesting experiments that may be carried out with its aid. The chief original feature is the use of two ready-made coated papers in the construction of the pile. The work would have been of greater scientific value if some quantitative results had been included.

War Map of Italy and the Balkan States. 30 in. × 40 in. (Edinburgh: J. Bartholomew and Co., n.d.) 1*s.* net in case, or 2*s.* 6*d.* on cloth in case.

THIS map covers an area extending from Geneva in the west to Odessa and Asia Minor in the east. On the north it reaches Vienna, and takes in Malta on the south. Insets, on large scales, of the Dardanelles, Constantinople and its environs, and Trieste and its surroundings are provided. Each separate State is distinguished in colour, and railways are shown. The map, which may be highly recommended, can also be obtained on rollers and varnished for 6*s*.

All About Zeppelins and other Enemy Aircraft. By F. Walker. Pp. 32. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1915.) Price 6*d.* net.

IT appears, from the preface, that "this little book is intended to explain fully, to a person of average intelligence, the nature and construction of enemy aircraft . . ." The author is a civil engineer, if one may so interpret the letters appearing after his name, but it is clear that his engineering training did not include an adequate course in aeronautics, or even freehand drawing, otherwise one might have been spared the many inaccuracies to be found in the book, and the still more remarkable sketches (signed "F. W.") purporting to represent aircraft. Fig. 20, page 25, is said to show "a British biplane in flight." It is in reality a very poor sketch of the Wright biplane of 1908, to the under-carriage of which the artist has added a misrepresentation of four wheelbarrow wheels. A somewhat better sketch of a *rear* view of the same machine is introduced in the following words: "Several of the Allies' biplanes have two propellers, as shown by the *front* view of a machine, Fig. 21."

Figs. 22 and 23 purport to be sketches of a "Taube" and an "Aviatik" respectively. Mr. Walker seems to have had misgivings, for he says: "But the details of these are so constantly changing, and the fact that they are utterly wrecked on reaching the earth, that we can only present the outward appearance in flight" (*sic*). It is difficult to believe that the delightful humour of these drawings, and of many of the statements in the book, is unintentional.

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.]*

More Early Animal Figures.

THERE is no better history of the rhinoceros, covering the knowledge of this animal in antiquity, than the essay contributed by Dr. Barthold Laufer to vol. xiv. of the Anthropological Series of the Field Museum

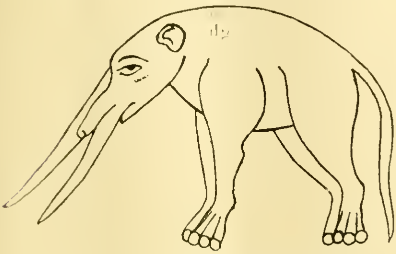


FIG. 1.—Elephant, from a Latin bestiary of the latter part of the 12th century.

(1914). It is illustrated by numerous figures, copied after early designs.

Two recent popular articles in English magazines deserve notice in this connection. One is by W. P. Pycraft, on the "Ancient Briton War-Horse," which appeared in the *Illustrated London News* for October 31 and November 28 of last year. The other is on

FIG. 2.—Giraffe, from a tomb at Thebes. Middle dynastic.

"Mediæval Ideas of the Elephant," by E. D. Cuming, in the *Field* for April 3 of this year.

One of the figures illustrating the latter article is here reproduced (Fig. 1), and we may also quote the following passage:—

"About few animals did our ancestors weave more curious and fantastic legends than they built up round the elephant. This animal captured their imagination, and no traveller's tale concerning it could be too marvellous to ensure acceptance."

In Figs. 2 and 3 are shown copies of two early Egyptian representations of the giraffe. The first of these is from manuscript 29,817 of the British Museum, already published in a coloured plate of

FIG. 3.—Giraffe, from an incised palette at Hierakonpolis. Early dynastic.

Wilkinson's "Ancient Egyptians," vol. i. The second is from an incised slate palette found at Hierakonpolis, figured by Quibell in "Memoirs of the British Exploration Fund." The probable period to which it may be assigned is early dynastic, or roughly, *circa* 5000 B.C.

G. R. EASTMAN.

American Museum of Natural History.

The Magnetic Storm and Solar Disturbance of June 17.

THE argument appears to me to drift again towards the old wrangle whether a particular solar disturbance has contributed to this or that particular magnetic storm. This is to me all the more surprising as for years past it has been urged that to connect the two phenomena in this direct way was to be deprecated and scientifically unsound; Fathers Cortie and Sidgreaves taking up a particularly uncompromising attitude in this respect.

I had the sun under telescopic as well as spectroscopic observation for many hours on twenty-seven out of the thirty days of last June, being prevented from doing so only on June 10, 23, and 29.

I submit that the mere telescopic appearance of a spot oubreak is not a safe index and criterion as to its activity, and consider that spectroscopic evidence should accompany ordinary direct visual observation. Now there was plenty of such evidence during the greater part of June, though spots were, at least at the beginning of the month, not very abundant. With June 12, however, things began rapidly to improve in this respect, a period of most intense activity being initiated by that most extraordinarily short-lived and superlatively active outbreak in abnormal low latitude (north) for the present phase of the activity period. The unprecedentedly rapid growth of this outbreak, which was really of an "explosive" intensity, was almost matched by an extraordinarily rapid decay, so much so that in spite of the magnitude the outbreak attained at its maximum, it did not even complete the one transit as a spot group, but merely as a faculic area.

Now this particular disturbance was presently accompanied by quite a number of others, which passed through similar stages of rapid growth, and in some cases of decay. Thus the southern activity belt, which had just previously been decidedly quiescent, showed within a few days no fewer than five distinct outbreaks extending over a longitude of some 140° or less (June 16), to which yet another was added by June 21, while in north latitude we had some four outbreaks, amongst which two formed the largest then on view.

The simultaneous eruptive paroxysms witnessed from June 13 to June 24 were so numerous that to me it appears utterly futile to endeavour to link a particular magnetic disturbance during those days with any of these scores of violent commotions. With such a multiplicity of intensely active foci scattered over the sun's disc all that can be safely claimed is to point to an undoubted abnormal magnetic terrestrial condition coincident with an abnormally active sun.

In NATURE for July 15 you give an interesting report of a fine aurora having been seen by Prof. Barnard at Yerkes Observatory in the night of June 16–17. Mention has also been made of a sudden magnetic disturbance as early in that month as June 7, by Dr. Chree, but I see no report from these two observers as regards a very fine auroral display which a trustworthy Canadian observer has reported to have taken place late in the evening of June 12. The same Canadian observer also witnessed the display of the evening of June 16, and there can be therefore no confusion of dates. I wish to lay emphasis on the auroral display of the night from June 12–13, because it practically coincided with the explosive development of a spot-outbreak near the east limb, which I witnessed in the early morning hours of June 13. The Greenwich (and other) photographs will bring the proof of the quite unprecedentedly quick development and decay of that particular solar outbreak, which reached a stupendous magnitude within less than two days in an abnormally low latitude, and accompanied by a display of activity, as witnessed through the spectroscope, of an intensity rarely seen.

ALBERT ALFRED BUSS.

"Barrowdale," 22 Egerton Road, Chorlton-cum-Hardy, Manchester, July 18.

Cement for Polarimeter Tubes.

IN NATURE of February 25, 1915, was printed a letter from me requesting suggestions for a cement suitable for fastening the end discs of polarimeter tubes in such a way as to resist the action of organic liquids at high temperatures. Several gentlemen kindly wrote to me privately making useful suggestions, and it may perhaps be of value to someone else engaged upon similar work if I mention briefly what these suggestions were.

Mr. O. L. Brady, of the Imperial College of Science, proposed fused silver chloride. Mr. Wm. Doran, Liverpool University, describes a zinc oxychloride cement, and another made by mixing a thick mucilage of gum acacia with calomel. Dr. Pickard suggests litharge and glyceric acid, but adds "that there seems to be some trick in regard to its application." Mr. Thomas Steel, of the Colonial Sugar Refining Co., Sydney, N.S.W., in a letter which the editor has forwarded to me, describes a preparation he has used for many years for cementing glass tubes into metal holders, etc. "A soft putty is made of litharge and glycerine, and used just like plaster of Paris, allowing about sixteen hours for setting. The hard-set compound resists water, oil, or alcohol, and is quite air-tight." I believe that a mixture of gelatine and acetic acid is also used as a cement, but to what extent it is resistant I do not know.

Another ingenious method of making a good joint, due, I understand, to Prof. W. Ostwald, was recommended to me, curiously enough, by M. le docteur Dolne, of Liège, a visitor amongst us on account of the war. By covering the centre of the disc with wax, and then immersing in an ammoniacal silvering solution, an annulus of silver is deposited on the disc, where it would come in contact with the end of the tube; the ends of the glass tube are treated similarly. Alternatively a deposit of platinum-black may be produced by moistening with platinum chloride solution and subsequent heating. The discs are then placed in position, the tube filled with a suitable silver or gold solution, one of these metals being then deposited electrolytically on the surfaces already silvered, or platinised, until the joint has become perfectly tight. The only question which might arise in regard to this seal is that, on heating, the different expansion of the glass and the metal might possibly cause leakage.

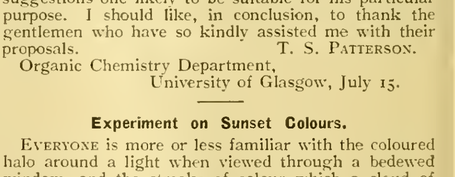
As the resisting power of most of these cements could not be definitely guaranteed by their suggesters, and the investigation of them all would constitute practically a research in itself, I followed the line of least resistance, and have tried, in the first place, a commercial preparation, "Cæmentium," recommended to me by Dr. J. R. Henderson, of the Royal Technical College, Glasgow. This is prepared by the Cæmentium Co., Ltd., Tanner Street, Bermondsey, London. Two tubes cemented with this material have stood well so far, resisting the action of boiling water and of some organic liquids up to temperatures of about 150°. A third broke down in the same circumstances, but was perhaps not properly cemented. I propose to try some of these other cements as occasion may require. In the meantime, any readers of NATURE seeking for such a substance may find amongst these suggestions one likely to be suitable for his particular purpose. I should like, in conclusion, to thank the gentlemen who have so kindly assisted me with their proposals.

T. S. PATTERSON.

Organic Chemistry Department, University of Glasgow, July 15.

Experiment on Sunset Colours.

EVERYONE is more or less familiar with the coloured halo around a light when viewed through a bedewed window, and the streaks of colour which a cloud of vapour presents in a strong light. The purity of colour in the diffraction halo depends essentially on the uniformity of size of the condensed droplets, and



the same remark may be applied to a cloud or mist. It occurred to me that the colours of a mist or cloud could be made more brilliant and extensive by controlling in some way the motion and distribution of the differently sized suspended droplets. I have accomplished this partially by the following apparatus.

The cylindrical surface of a tin can A was wrapped closely with a sheet of thick blotting paper and supported in an upright position. A board B about 2 ft. square, with a central hole in it, was fitted over the can in a horizontal position. Narrow strips of wood were nailed to the edges of the board to form a shallow ridge. One of these strips C was made adjustable. The blotting paper was moistened with water, and this was evaporated by blowing steam through the water in the can. The water vapour at a temperature of about 80° will stream steadily upwards from the surface of the can and flow over the board in an undulating cloud, separated from the surface of the board by a thin transparent layer of uncondensed vapour. On illuminating the cloud with a nearly horizontal beam of sunlight S, large patches of gradually changing colour appear when the eye E is directed slightly upwards towards the lower surface of the board. The beam of sunlight should be adjusted so that it just fails to illuminate the surface of the board, and the colours are best seen when this surface is blackened. The air around the board should also be quite undisturbed. These colours rival in brilliancy those to be seen on soap films, and present the features of sunset colours. It appears, then, that some of the brilliancy and extensiveness of sunset colours is due to a quiescent state or regular motion of the clouds or mist at sunset, and also to a distribution into layers of droplets of nearly uniform size.

F. W. JORDAN.

South-West Polytechnic, Chelsea, S.W.

Non-Poisonous Character of Nitroglycerin.

WITH regard to the dose of nitroglycerin referred to in the notice of a book in NATURE of July 22 (p. 560), it may be useful to have the facts correctly stated. The reference was clearly to a passage in the "Extra Pharmacopœia" (sixteenth edition, vol. i., p. 527), in which I say:—"An employé in the author's laboratory (1905) ate a piece of the nitroglycerin mass weighing about 2 oz., mistaking it for ordinary chocolate. A bad headache supervened, necessitating his lying down, but he was at work again on the following day."

The "mass" in question is composed of nitroglycerin with chocolate in the proportion of 1/100 grain in 2½ grains; the amount of nitroglycerin consumed therefore by the predatory individual on that occasion was approximately 3½ grains.

May I add that the young man was a German apprentice of mine, and that his exclamations in half-broken English, to the effect, "Mein Gott, I shall die, I shall die!" as he gavotted round the laboratory waving his arms about, were the cause of some mirth to bystanders. As things have turned out he possibly *has* died by now from the effects of nitroglycerin employed in another way.

Considering the powerful vasodilator action of this and allied drugs (the late Prof. Leech determined that the circulation is distinctly affected by even 1/1000 grain of nitroglycerin), it is of interest to realise to what a remarkable extent they are tolerated. Single doses of 5 grains and daily doses of 20 grains have been administered medicinally with safety, according to the *Brit. Med. Jl.*, Epitome ii., 1905, p. 52. Has any one of your readers any knowledge of higher amounts having been taken?

W. H. MARTINDALE.

10 New Cavendish Street, London, W.

MR. MARTINDALE'S extremely interesting letter supplies the clue as to how anyone could mistake nitroglycerin for chocolate, but as the book referred to gives no reference and omits the word "mass" after nitroglycerin, the ordinary reader will gain a somewhat confused idea as to the toxic action and characteristics of nitroglycerin. THE REVIEWER.

The Principle of Similitude.

IN NATURE of March 18, Lord Rayleigh gives this formula, $h = \kappa a\theta . F(avc/\kappa)$, considering heat, temperature, length, and time as four "independent" units.

If we suppose that only three of these quantities are "really independent," we obtain a different result. For example, if the temperature is defined as the mean kinetic energy of the molecules, the principle of similitude allows us only to affirm that $h = \kappa a\theta . F(v/\kappa a^2, ca^3)$.

D. RIABOUCHINSKY.

Aerodynamic Institute, Koutchino.

Structure of Hailstones.

WITH reference to the particularly violent hailstorm which passed over S.E. London on Saturday afternoon, July 24, I observed at Woolwich that the hailstones, apart from being very large, had a common shape and structure which may perhaps be worth recording. All the stones examined were either oval or pear-shaped, but not of uniform size; the broad half consisted of clear ice, while the other half was uniformly opaque or closely stratified with alternate layers of clear and opaque ice. S. L. ELBORNE.

77 West Park, Eltham, S.E., July 26.

COTTON AS A HIGH EXPLOSIVE.

AT the recent meeting of the Society of Chemical Industry held at Manchester, Mr. W. F. Reid is reported to have made the statement that nitrated cotton is not a high explosive, though every chemist knows that it is the typical high explosive. The fact that certain newspaper writers have differentiated between nitrated cotton and nitrated benzene or toluene, or any other coal-tar derivative, has nothing to do with the differentiation of a high explosive (which is of itself nitrated, and contains within itself sufficient oxygen to allow of its explosion) and those mechanical mixtures, such as gunpowder, which have been now superseded. A letter from Sir William Ramsay published in the *Times* of July 19 makes all these matters perfectly plain, and no responsible person would dispute them. I was present in the House of Lords when Lord Charnwood brought his statement before that House, and I also heard the rest of the debate, including the answer of the Marquess of Crewe. The House, consisting of those who are necessarily laymen so far as their chemical knowledge is concerned, found some difficulty in following the arguments as to whether any substitute for cotton could be effectively used.

To the chemist the matter is perfectly plain, and it has been stated with some degree of precision in an article which appeared in NATURE of July 1. It is true, and has been admitted from the very start of what is now known as the "Cotton Campaign," that some form of nitrated cellulose can be made from anything which contains cellulose. There is not the slightest difference of scientific opinion on this matter, and every competent chemist will concur with what I say, but in practical matters things stand on a totally different footing. There must not only be a regularity of the supply of material, but there must be uniformity of quality; and, in the article already referred to, this point has been made tolerably clear. It is by no means taking too high a position to state that, unless such uniformity is certain, the task of any works' manager will be so heavy and the risks which he will encounter so great that his factory will be endangered. Quite apart from this, even supposing he surmounts such obstacles, the material which he will produce will be markedly inferior to that which he can make in the ordinary course of his business. It has been quite rightly pointed out by people of expert knowledge and authority that the ballistics on which artillerists' calculations are based are demolished by any alteration in his charge. Sir William Ramsay is perfectly right in showing, not only that the pointing and therefore the sighting of the gun must be altered, but also that the chamber in which the explosive is fired must be enlarged if any form of nitro-cotton inferior to the standard material is used; and it is quite conceivable that the weight of the projectile and the pitch of the grooving would also have to be changed. Without going too closely into such highly technical matters, it can be said with full confidence that the gunner would have his trade to learn again, and this can scarcely be done in the midst of a war.

Many references have been made to the use of substitutes for cotton in the manufacture of nitrocellulose, but they are all of a somewhat academic kind. As has been stated above, no one doubts that such things can be used, but it is a sort of misapplied ingenuity which seeks to find sources of cellulosic materials; such ingenuity would be quite thrown away on a practical maker. There is one possible danger, due entirely to the laxity of the control of the import of cotton at the beginning of the war; it is that between August 4 and the present date the German chemists have been sedulously endeavouring to utilise some such materials. Eleven months, now nearly twelve, is enough even for a German chemist to make some progress; and it may be that a nitro-cellulose of a sort may be being made in Germany now from material other than cotton. The fact remains, however, that the Germans are eagerly buying cotton, and are doing their utmost to obtain more than their legitimate share of the new crop which should be on the market in a month or two.

There is much truth in the statements which have been made in many periodicals—in the *Times* on several occasions and in the *Engineer* a good many months ago—to the effect that we English people have been a little too modest. Because of the great flood of genius which governed the German nation somewhere in the middle of the last century, and gave us those deathless names, Bunsen, Kekulé, Liebig, Meyer, and others, and because some of our present chemists of the highest rank were trained under these great men, the ordinary British public nas been obsessed with the idea that chemistry is a German science. A very little knowledge of the history of chemistry would show that such a mistake is almost childish. Our French friends have claimed that chemistry is a French science, but those of us who have read the work of Robert Boyle or have studied the work of Priestley, Cavendish, Berzelius, know very well that chemistry is cosmopolitan. The arrogance of German soldiers has been reflected in a similar arrogance of German chemists; and those eminent in our land whose names it would be impertinent to recite, as well as such of our colleagues now living, whether Scandinavian or Dutch, to whom again it would be improper to refer, have their own opinion as to the correctness of any claim by German chemists to a prerogative in science.

To return to the question of cotton, I think there is not the slightest doubt among those whose opinion is of value that raw cotton or cotton waste is absolutely essential for the production of a satisfactory propulsive explosive; and this view has been accepted by responsible statesmen in both Houses. Personally, investigations of this question through commercial channels have convinced me that this is a fact, and I am perfectly prepared to maintain it against anyone who claims an equal authority.

Bertram Blount.

THE WAR AND CHEMICAL INDUSTRY.

On the occasion of the annual meeting of the Society of Chemical Industry, of which an account appeared in Nature of July 22, there was a notable change in the character of its business as compared with that of previous annual gatherings. We learn from Prof. Henderson's presidential address that, in the opinion of the society's council, too much of the time over which the meeting extends had hitherto been devoted to purely social functions, and that in the past no sufficient advantage had been taken of the opportunity afforded by such an assemblage of technologists to lecture them on matters which superior persons might hold to be for their general good. No doubt the council, like the rest of us, is impressed with the seriousness of the strenuous and critical times in which we are living. Whatever semblance of frivolity may have hitherto characterised these annual gatherings obviously would be out of place on the present occasion. Accordingly, with the co-operation of the Manchester section, a special programme was arranged which should at once be "topical" and illustrative of the good resolutions of the council.

Whether their hopes and wishes have been wholly realised may be open to doubt. Four special papers, in addition to the president's address, were presented for the consideration of the members. Naturally, since so much has been said during the past ten or eleven months concerning the relations, immediate and proximate, of applied chemistry to the war, and to matters arising, directly or indirectly, out of it, it was almost inevitable that this comprehensive subject should be the dominant feature of the communications. Prof. Henderson, as might be expected, could not refrain from some reference to a feeling of disappointment that fuller use had not been made of the society's desire to be of national service. It is regrettable on all grounds that the scientific resources of the nation have not been systematically utilised by the Government. Some help, he admitted, has been rendered, but more, he thought, might have been done by a more efficient organisation—say, by the creation of a "central body" which should have the duty on the one hand of keeping in intimate touch with the Admiralty, the War Office, and the Ministry for Munitions, and on the other of referring to the societies representative of the different branches of pure and applied science the questions with which each is particularly fitted to deal. How far this conception of a scientific clearing-house differs essentially from that which has actually been set up by the Royal Society is not, however, very clear.

Naturally, too, Prof. Henderson bemoans our backsliding as regards the position and future prospects of our chemical industries:—

> We have been made to realise more clearly than ever before that during the last forty years chemical industry in Germany has made marvellous strides in advance, whilst in this country it has by comparison stood still or even gone back. We have to admit that certain branches of applied chemistry, particularly the manufacture of dyestuffs, of synthetic drugs, and of organic compounds and fine chemicals in general, have passed almost wholly out of our hands, or rather have never been taken up to any notable extent in this country.

As to the real reasons for German progress and British backwardness there is little doubt, in Prof. Henderson's mind. He shares the conviction of Profs. Perkin and Meldola that it is due partly to our failure to realise that "scientific research work, carried out in the laboratory, is the soul of industrial prosperity," and partly to the mutual aloofness and reserve of manufacturers and teachers. But, whatever may be the true causes, Prof. Henderson is emphatically of the opinion of most sensible men that it is about time "we cut the cackle and came to the 'osses"—or, as he prefers to put it, "that we shall refrain from talk and proceed to action." "Let us admit frankly that we have left undone many things which we ought to have done, and, having confessed our sins, let us unite in striving to secure the future prosperity of our industries."

We might well apply this injunction to certain papers which followed the president's address. Of them it may be said they were *Vox, et praeterea nihil.* The author of one paper bewails our proneness to label-worshipping, and the "stupid confusion" which paralyses "a bewildered public" in its efforts to distinguish the chemist, properly although not legally so called, from the pharmacist or apothecary. He tilts against the system under which our schools and colleges are governed, considers that teachers are "victimised by the principle of the hole-and-corner," and is of opinion that appointments should be made by the candidates making the selection themselves.

Another author tilts against everybody and everything in general—whatever is, is *wrong*, is the refrain of his paper—English education and English life, the British public, the Board of Trade and the War Office, the Home Office, the Local Government Board in particular, the Government of course, collectively; lawyer-politicians as a class, with special reference to the late Lord Chancellor and Lord Moulton of Bank for interfering in matters with which they had no concern; Oxford and the Royal Society and the general body of men of science—all alike come in for cavil, censure, and condemnation. Even the society he was addressing "needs to wake up." It "must intervene actively in the promotion and protection of chemical industry." In spite of what others regard as more than thirty years of creditable activity, the members were told it has been "almost supine hitherto," and has "allowed others to tinker with matters" which primarily should be its concern. No doubt the somnolent members, when they did wake up, rubbed their eyes in hopeless wonderment as to who had been poaching upon their preserves. But they were probably reassured when they learned that it was only the deputation, "nominally representing the Royal and Chemical Societies"—"academic parties in science" and "first cousins to the lawyer-politicians"—who recently waited upon the Presidents of the Boards of Trade and Education, and so presumably they went comfortably to sleep again.

It is one of our national characteristics that we rather enjoy self-depreciation, and that we have a good-humoured toleration of the critic who reminds us of our national shortcomings. But something depends upon how it is done. The implied reproof, to begin with, must be intrinsically just and merited. If it is so recognised, it adds to its effectiveness when administered with a certain delicacy and restraint of statement. But no useful purpose is served by reckless assertion and indiscriminate blame, declaimed in an exuberant philippic.

It is a relief to turn to the paper by Dr. Beilby on chemical engineering, and to that by Sir W. H. Lever on copartnership in chemical industries; for it is papers like these that are of real use to us at the present juncture. According to Dr. Beilby our "colleges have two distinct functions to perform, and it is best that this should be clearly recognised; first, to allow the future leaders in applied science to come naturally to the top during their training; and secondly, to prepare a large number of well-trained professional men for the organisation and development of industry." He fears that the making of practical chemists has suffered severely from the fallacy that all students ought to aim at being pioneers in some branch of their science. "Science and industry alike call aloud for *real pioneers*, for without these the highest type of progress cannot be realised. This call, however, cannot be met by the premature stimulation of 'originality' in men of very ordinary endowment. The effect of this stimulation is not merely futile, it is positively mischievous, for it raises an ideal which for the ordinary man is quite inappropriate during his preparation for a life of serious practical endeavour." The remarkable development of chemical industry in Germany has resulted much more from the large command of chemists and engineers of sound professional training and ability than from the possession also of an even larger supply of research chemists of mediocre ability.

Sir William Lever's paper is a weighty contribution to what is at the present crisis a very serious problem. One of the most distressing features of the times is the widespread unrest in the labour world concerning the division of the profits arising from the remarkable activity of certain industries connected with the war. So far it has not extended to any marked extent to the chemical industries, probably because these are not subjected to the same disturbing influences as, say, the coal-miners. But Sir William Lever's paper is a timely account, judicious, impartial, and dispassionate, of the working of a system which is pursued with signal advantage and success in the great organisation which he controls, and as such it may be commended to the thoughtful consideration of all employers of labour.

THE ROYAL GEOGRAPHICAL SOCIETY'S WORK ON THE ONE-MILLION MAP.

MR. A. R. HINKS, secretary of the Royal Geographical Society, described at a recent meeting of the society the work which has been carried out, and is still in progress, on a map on the scale 1/1,000,000. It is well known that, before the outbreak of war, conferences of representatives of the principal Powers had met in London and Paris, and had come to an agreement as to the production of a map on this scale, to cover ultimately all lands, on a uniform projection and with uniform methods of representation, etc. A few sheets had been produced in various countries. They were scattered, in some instances imperfect and not available in any quantity, and in any event useless to meet even partially the necessity which was felt, almost at the outset of the war, of a map to cover uniformly Western and Central Europe and Asia Minor and adjacent areas affected by military operations. Even for Europe no such map existed, and it was necessary, in taking a broad view of the operations, or for any such purpose as that which will ultimately become of prime importance, the tracing of boundaries, to pass at certain points from maps of a particular scale and method to others totally different in every respect. People are prone to comment that the scale 1/1,000,000 (nearly 16 miles = 1 inch) is too small even for such general purposes, but it is not so. It allows the representation of important places, railways, roads and boundaries, rivers, and elevation by means of contour lines, either alone or in conjunction with layer colours.

Such a map, then, was undertaken by the Royal Geographical Society under the direction of the Geographical Section of the General Staff. The society's responsibility has extended to the compilation of construction drawings from the materials available on the spot, while the engraving and reproduction is being carried out by the Ordnance Survey Department. Methods have been used which, if slightly rough, have allowed of high speed, and a number of the sheets are already on the market in a preliminary issue. The work at the society's house has been done by Mr. Hinks and a number of volunteer fellows, all more or less accustomed to map-compilation, with the assistance of certain external advisers and a few trained draughtsmen.

Despite the possibilities for error which are inseparable from work done thus rapidly and without access to local information at the moment —possibilities which were frankly discussed by Mr. Hinks—there can be no question that a valuable and important task has been accomplished. Much experience has been gained. In certain respects the methods laid down at the international conferences have been improved upon. Two of the most important departments in which the work marks a real scientific advance are (1) the solid endeavours which have been made to overcome the immense difficulties of regularising the spelling of place-names in Central and Near Eastern Europe; (2) the contouring of the maps, which, in the same localities, often represents a reasoned collation of very imperfect sources, and the application to the data thus obtained of what may be called topographical sentiment of a high order. The systems of transliteration and hints as to pronunciation are indicated, where necessary, on the maps themselves. The work of compiling the physical outlines and contours has enabled a proper value to be set on many of the well-known official and other maps; notably it has resulted in the detailed criticism of the great Austrian staff map of 1/750,000, which does not emerge triumphantly from this test.

It is to be hoped that on the solid foundation of preliminary work thus laid will be raised, after present exigencies have been met, a structure of permanent value to geography generally; these maps should ultimately be revised and executed by the best methods, excellent as the present results are for the time being.

RECENT STUDIES IN THE DYNAMICS OF LIVING MATTER.

THERE is no falling off in the stream of work which comes from Prof. Jacques Loeb's laboratory in the Rockefeller Institute, from which we have now before us some ten or a dozen papers, mostly by Prof. Loeb himself, all published since the beginning of last year. They deal with various subjects in that field of comparative physiology, or dynamical biology, which Loeb has so diligently reaped as well as sown. Most of them are concerned with one or other of three topics, the phenomenon of heliotropism, the inexhaustible problem of growth, and, lastly, the conditions which determine or which prevent the entrance of the spermatozoon into the egg.

In Prof. Loeb's book, which bears the title set at the head of this short article, there is a well-known chapter on heliotropism, that is to say on the tendency of plants to turn towards the light, and on other kindred phenomena manifested both in plants and animals; for the polypes of a hydroid colony such as Eudendrium, or the tube-dwelling worms such as Serpula or Spirographis, also bend towards the light, and if they be illuminated by a single beam they grow steadily in the direction of its rays. It is characteristic of the plant (or rather of the green plant) that it represents a peculiar type of machine which is capable of turning radiant energy into chemical energy, and so ultimately into mechanical work; and in the case of the plant, "the permanency of this kind of machine is guaranteed by the presence of an automatic arrangement, whereby their stems turn towards the light." So Loeb is inclined to read into this phenomenon what we might call a modified teleology, such indeed as, in one form or another, refuses to be kept out even of our most modern biological speculations.

In the chapter already alluded to, published some nine years ago, our knowledge was said to be very scanty as to the relative heliotropic efficiency of the various parts of the spectrum, little more being known than that the more refractive rays, the green, the blue, and the violet, were more effective than the yellow and the red. "There exists thus, apparently," said Prof. Loeb, "a division of labour, the longer light-waves accelerating assimilation, and the shorter waves accelerating heliotropism;"—just (we might say) as there is obviously a "division of labour" between the rays which illuminate and those which warm us.

Two of Prof. Loeb's recent papers (by Dr. H. Wasteneys and himself) (Pr. Nat. Acad. of Science, January, 1915, and *Science*, February 26, 1915) are devoted to the question of the identity of heliotropism in plants and animals, and thereby to an inquiry into the particular wave-lengths of light to which, in one case or another, they are most sensitive. Instead of exposing the organisms to the solar spectrum itself, as had been done in earlier and simpler experiments, the writers (using a carbon arc spectrum) allowed the light from particular portions of it to pass through narrow slits, and then reflected it in a monochromatic beam upon the subject of their experiments. They soon arrived at the simple but very remarkable result that there are two particular regions of the spectrum the rays of which are especially effective in causing organisms to turn, or to congregate, towards them; these regions lie (1) in the blue, in the neighbourhood of a wave-length of 477 $\mu\mu$, and (2) in the yellowish-green, in the region of $\lambda = 534$ $\mu\mu$; and these two wave-lengths affect different organisms, with no very evident relation to the nature of these latter. Thus the blue rays (of 477 $\mu\mu$) attract the infusorian Euglena, the hydroid Eudendrium, and the seedlings of oats; while the yellowish-green rays (of 534 $\mu\mu$) in turn affect the protozoon Chlamydomonas, the little water-flea Daphnia, and the larvæ of barnacles.

These facts add a quality of precision to many older and vaguer observations, for instance, to Paul Bert's discovery (in 1869) that Daphnia swims towards the light in all parts of the visible spectrum, but most rapidly in the yellow or the green. The particular wave-length of 534 $\mu\mu$ is especially remarkable, because it coincides with a determination by Trendelenberg that the visual purple of the rabbit's eye (which is not affected by red and very little by yellow light) is bleached most rapidly by light the wave-length of which is 536 $\mu\mu$. It would seem, according to Loeb, that among the lower organisms we have to deal with two separate photosensitive substances, which determine their heliotropic reactions; that these are distributed without regard to the systematic boundaries, even between plants and animals; and that one of the two, occurring even among very lowly organisms, has characters similar to, and is perhaps identical with, the visual purple of the highest type of eye.

In another paper (*Science*, November 6, 1914), still dealing with the effects of light, Prof. Loeb relates some remarkable observations on the action of ultra-violet rays upon unfertilised eggs, adding by these new experiments a curious detail to the many facts regarding artificial fertilisation, by chemical or physical means, which we associate with his name as their prime discoverer. On the ground that ultra-violet rays are known to have a sterilising effect, that is to say to be capable agents in the destruction of cell-life, and that, according to Loeb's own experiments, the very substances which induce "cytolysis" in the living cell are also capable (under proper conditions) of producing artificial parthenogenesis, Loeb thought it likely that these rays would also prove to be effective stimuli, under the appropriate conditions, of parthenogenetic development. He exposed the unfertilised eggs of a sea-urchin for ten minutes to the light of a quartz mercury arc lamp, and found that the majority of the eggs formed "fertilisation membranes"; when kept cool they further proceeded to segment, but ere long perished; an addition of hypertonic sea-water, however, enabled them to develop into larvæ, though few advanced beyond the gastrula stage. It was remarkable that a cover-glass, 0·1 mm. thick, was sufficient to prevent all action on the part of the light, a fact which bears closely on the wave-length of the rays which produced the action.

The discovery here mentioned is certainly interesting as a specific case of the effect of radiant energy on living protoplasm; but its precise degree of interest turns largely on the importance which we may attach to the formation of a surface-membrane as an essential preliminary to the development of the egg. According to Loeb this phenomenon is of supreme importance; for the question why an unfertilised egg cannot grow, and why a fertilised egg can grow and divide, depends, according to him, entirely on the condition of the surface layer of the egg; the nature of this cortical layer determines whether the egg be in an active or a passive phase, and the essential factor is a change in the rate of oxidation, to which the condition of the cortical layer directly leads. "The forces which induce the egg to develop are, therefore, localised *at the surface of the cell.*" This is a somewhat hard saying, but in Prof. Loeb's hands it leads to many suggestive and stimulating reflections. The whole subject is discussed in his book on "Artificial Parthenogenesis, etc." (1913), and in a paper now before us, on the Stimulation of Growth (*Science*, May 14, 1915).

D'Arcy W. Thompson.

SIR SANDFORD FLEMING.

The death of Sir Sandford Fleming on July 22nd at eighty-eight years of age has deprived the world not only of one of its greatest engineers, whose constructive works revolutionised trade and commerce by providing increased facilities for intercouse, but also of one who in various ways proved himself a pioneer, advocating and supporting measures the importance of which had not yet penetrated the public mind. He will be longest remembered for his work on the Canadian Pacific Railway and for his successful advocacy of a cable across the Pacific, which has proved of so much value to the commercial world. But in smaller matters he exerted himself not less strenuously and usefully. In a new country where material interests are many and pressing, he early saw the necessity of upholding pure science for the encouragement it could give to arts and industry, and with this view, so far back as 1849, he promoted the foundation of the Canadian Institute, which after demonstrating its usefulness in various directions, was recently incorporated under a Royal Charter.

Not less farseeing and useful was Sir Sandford Fleming's proposal in 1879 to legalise a universal day, beginning at mean noon of Greenwich time, the hours being counted continuously from 0 h. to 24 h. Five years later this suggestion bore fruit at the conference at Washington, summoned to consider more uniform methods of reckoning time, and at which it was resolved to adopt a single prime meridian for all nations in place of the initial meridians, favoured as this mode of reckoning was by international jealousies. At this conference Sir Sandford Fleming represented Canada, and it was there that the zone system of reckoning with which his name has been intimately connected was first ventilated. The convenience of adopting a standard time differing by an exact number of hours from universal time was insisted upon, and it was shown that it was not necessary, as maintained at a previous conference at Rome, to retain exact local time side by side with universal time. We have not yet achieved the arduous task of counting the hours consecutively from 0 to 24 h. as recommended, but the method is so eminently desirable in civil affairs as being thoroughly explicit and rendering unnecessary the distinguishing suffix a.m. or p.m., that we may hope the practical advantages will become apparent to the public as they were to the eminent engineer whose death we regretfully record.

NOTES.

The Société Helvétique des Sciences Naturelles will hold, at Geneva, on September 12–15, its ninety-seventh annual session, which will coincide with the hundredth anniversary of its foundation. On account of the disturbed conditions existing at the present time, the council of the society has decided to celebrate this anniversary very quietly, and not to send the usual invitations to foreign scientific societies, or to men of science residing outside Switzerland.

The Toronto correspondent of the *Times* announces that the Commission appointed by the Ontario Government to investigate the production and shipment of nickel in relation to the conditions created by the war consists of Mr. G. T. Holloway, of London (chairman); Prof. W. G. Miller, provincial geologist; Mr. McGregor Young, K.C., Toronto; and Mr. T. W. Gibson, Deputy-Minister of Mines. It is understood that in the course of its investigation the Commission will visit England and Norway and the New Caledonia mines in the South Seas. The Commission will also consider if nickel can be successfully refined in Canada. The importance of nickel as a munition metal was described by Prof. Carpenter in an article in Nature of July 15 (p. 539).

A notable instance of the advantage to the State of calling in the aid of science in relation to difficult problems bearing directly on the well-being of our fighting forces is illustrated in the exhibit recently installed in the central hall of the Natural History Museum showing the work done in connection with an investigation undertaken jointly by the War Office and the Museum to determine the origin of damage to army biscuit by insect pests, and to prevent or minimise such infestation. Attention was directed to the matter some time ago by the fact that ration biscuits exported to the colonies became after a time quite unfit for consumption, owing to the ravages of certain moths and beetles—this was specially noted in South Africa, Ceylon, Gibraltar, Malta, Mauritius, and the Sudan. In answer to an application from the War Office, the trustees of the British Museum placed at the disposal of the military authorities for the purpose of the inquiry the services of Mr. J. Hartley Durrant, the expert in charge of the collection of microlepidoptera at South Kensington. It is most satisfactory to learn that these researches, which have been carried out jointly by the two departments concerned, extending over a period of three years, have ensured the protection of army biscuit from the possibility of such attacks by insects in the future. The insects met with during the inquiry were all widely distributed species the range of which has doubtless been greatly extended by commerce.

Prof. A. Arnaud, whose death will be deplored by chemists and pharmacologists, had made a world-wide reputation by his researches on ouabain, strophanthin, digitalin, cupreine, etc. For nearly a quarter of a century Prof. Arnaud occupied the chair of chemistry at the Museum of Natural History in Paris, and the numerous researches that he published have made his name familiar to the chemists and pharmacologists of all countries. By his death science has lost one of its most able exponents.

It is with regret that we record the death of F. P. J. Guéguen, late professor of botany in the School of Agriculture at Grignon. Prof. Guéguen was born at Loudéac, in Brittany, in 1872, and, having trained at the Ecole Supérieure de Pharmacie, became a hospital pharmacist in 1895. In 1899 he gained the title of doctor of pharmacy, his thesis being an account of researches on the mycelia present in pharmaceutical solutions. He afterwards devoted himself chiefly to cryptogamic botany, became assistant professor in the Ecole de Pharmacie in 1904, and for the last few years of his life occupied the chair of botany in the School of Agriculture at Grignon. Prof. Guéguen published numerous papers dealing chiefly with cryptogamic botany.

The death of Sir James Murray, on July 26, removes a well-known figure from Oxford society. For more than thirty years his face and form had been among the most familiar sights in the University. His courteous manners and address, and his air of grave distinction, attracted the notice even of strangers, but to those who knew him intimately he was one of the most delightful of associates. Learned, but no pedant, keenly interested in all departments of mental activity, possessed of a wide acquaintance with science and literature, and equipped with knowledge, probably unequalled, of his own special branch of inquiry, he was always ready to impart information from the immense stores of his erudition. He had the gift of interesting others in his own subject without forcing it upon them or wearying them with over-minute details. His enthusiasm in his great work of the New English Dictionary, though evident to all who knew him, was held within due bounds by a plentiful endowment of common sense and a certain good-humoured shrewdness of nature, which was no doubt attributable to his northern origin. His conscientiousness was extreme. He spared no pains in ensuring the utmost accuracy of definition for the technical terms in the dictionary, taking every opportunity of consulting those best qualified to advise on such subjects. But he was no mere compiler, and his own mathematical and scientific knowledge was employed with excellent results. Though in his bearing the pink of courtesy, he could be trenchant in literary or philological criticism. Amusing stories have been current of the way in which some of his comments on other lexicographers have been toned down for publication by his assistants. His death at the age of seventy-eight has disappointed the hopes of those who looked forward to see him finish the great work now so near completion.

By the death of Dr. Alexander Stewart, principal of St. Mary's College, St. Andrews, which occurred somewhat suddenly on July 21, science has lost a genial friend and supporter, who, throughout his twenty-one years of office as principal, was ever ready in a quiet and judicious way to champion her cause. As an old and distinguished student of St. Andrews, for he was first bursar in 1864, and, later, Lord Rector's prizeman, and a graduate of the University, he took a deep interest in all the modern developments of the museum, the marine laboratory, and the lectureships of botany and geology, the latter specially owing much to his fostering care. Moreover, though he did not, like his talented predecessor, Dr. John Cunningham, profess to study divinity scientifically, yet he took a broad and modern view of his subject, and by his erudition, fine voice, and great lucidity of expression, was ever a popular lecturer and preacher. His first appointment was to the parish of Mains and Strathmartine, near Dundee; his second to the chair of systematic theology in Aberdeen University; and his third to the principalship of St. Mary's College, St. Andrews. He was moderator of the General Assembly of the Church of Scotland in 1911, the year in which the five hundredth anniversary of his own University was celebrated, but after installation in the moderatorship he caught a chill, so that he was only able to appear on the closing day. He exerted himself, however, to fulfil all the other onerous duties during his year of office. In his early days he was an active gymnast and student-president of the University Club, in the welfare of which, as in that of the old University Battery and modern O.T.C., he took a deep interest to the last. As a colleague he gained the esteem of all from his straightforward, genial, and considerate character. His broad sympathies with science and his unselfish and modest bearing won for him the respect alike of colleague and student, as well as gave him a wide circle of scientific friends who mourn his loss.

In the article upon "The Evolution of the Goniometer," which appeared in Nature of July 22, it was no part of the historical sketch to give a systematic list of the instrument-makers who had constructed the several types, but since, as Mr. Conrad Beck has pointed out to us, it might appear as if British instrument-makers had not borne their share, we think it right to remove any such misapprehension. Messrs. Troughton and Simms have constructed many fine instruments for, among others, Sir Henry Miers, Dr. A. E. H. Tutton, and the British Museum, and Dr. Hutchinson's universal goniometer, which was described and illustrated in the article, is made by Messrs. James Swift and Son, who kindly lent the block to illustrate the article. In the goniometer, as in all classes of instruments, British manufacurers stand second to none in excellence of workmanship; it is no fault of theirs that owing to the comparative neglect of the study of crystallography in this country they have found so little demand for crystal-measuring apparatus.

In continuation of the register published in Nature of July 15 and 22 we are informed that the following members of scientific staffs are on active service with H.M. Forces:—*Plymouth: Marine Biological Association's Laboratory*:—L. R. Crawshay, naturalist, Lance-Corpl. 1st King Edward's Horse; E. W. Nelson, naturalist, Lieut.-Commander, Royal Naval Division; J. H. Orton, naturalist, 2nd Lieut. Royal Garrison Artillery; E. Ford, assistant naturalist, 2nd Lieut. 4/2 London Royal Fusiliers. *Kingston, Derby: Midland Agricultural and Dairy College*:—J. H. Beale, lecturer in horticulture, Lance-Corpl, 2/7th Batt. Sherwood Foresters; F. Knowles, soil analyst, private, 2/7th Batt. Sherwood Foresters; H. M. McCreath, assistant lecturer in agriculture, 2nd Lieut. 8th Royal Scots Fusiliers; J. G. W. Stafford, assistant lecturer in dairying, 2nd Lieut. 11th West Riding Regiment; J. C. Wallace, lecturer in horticulture, Corpl. motor despatch rider, Cavalry Corps, Expeditionary Force.

The *Cambridge University Reporter* of July 13 publishes the report of the Antiquarian Committee for 1914. In spite of some delay caused by trade disputes, good progress has been made in the erection of the second section of block ii. of the new museum. The divisions of the building will be named after generous benefactors: Messrs. C. E. Keyser, C. C. Babington, and A. A. Bevan. Other donors have provided funds for the fittings of the new building, but the lack of showcases still retards the work of arrangement, and it is difficult to prevent damage to specimens stored away in boxes. A long list of accessions to the collection is given, and the master and fellows of Trinity College are thanked for permitting the transfer on deposit of all the ethnological and antiquarian specimens which had accumulated in the college library. There is still ample opportunity for other benefactors to contribute to this laudable undertaking.

Prehistoric cultural centres in the West Indies forms the subject of a brief essay in the Journal of the Washington Academy of Sciences for June. Remarking that the American Indian did not reach America until he had arrived at the Neolithic stage of culture, and did not make acquaintance with the use of metals until introduced after the discovery of America by Columbus, he goes on to point out that as a conseqence of this prolonged use of stone they attained to a higher standard of excellence in the use of this material, both in the fashioning of tools and architecture, than was ever attained by the Neolithic peoples of the Old World. In discussing the remains left by the aboriginal inhabitants of the West Indies he insists that three cultural epochs must be recognised—the cave-dwellers, the agriculturists, and the Caribs. The most primitive of these is found represented by objects found in the floors of caves or in the numerous shell-heaps scattered from Cuba to Trinidad. But the Caribs seem to have been preceded everywhere by the Arawaks, as is shown by the fact that pottery of high excellence has been found on all the islands inhabited by Caribs who, being a nomadic people, had not acquired this art.

The Journal of the Royal Microscopical Society for June (part 3) contains the presidential address by Prof. G. Sims Woodhead on "Some of the Micro-biological Problems of the Present War." Prof. Woodhead discusses the question of antiseptic versus aseptic surgery, and is convinced that for the treatment of wounds received on the battlefield antiseptics should be used. The sterilisation of water by means of chlorine and causation of cerebro-spinal fever are other subjects dealt with in this interesting address.

The lately issued report, No. 3, of the Danish Oceanographical Expeditions, 1908–10, is mainly occupied by K. Stephensen's account of the Isopoda, Tanaidacea, Cumacea, and Amphipoda, many of the species being illustrated by clear outline drawings. P. Jespersen's paper on deep-sea fishes of the family Sternoptychidæ is noteworthy for its detailed distributional maps. Madame P. Lemoine describes the Calcareous Algæ, illustrating her work with structural figures and a well-printed photographic plate.

At a meeting of the council of the Ray Society, held on July 22, Prof. E. B. Poulton, vice-president, in the chair, it was resolved to issue for 1916 the second volume of Mr. W. C. Worsdell's "Plant-Teratology," comprising the flower, with twenty-seven plates, several being coloured, and about ninety text-figures, completing the work; and also the second part of vol. iii. of Prof. McIntosh's "British Marine Annelids," consisting of twenty-eight plates with descriptions, six uncoloured plates being substituted temporarily for coloured plates, which cannot at present be obtained on account of the war.

A large number of the Annals of the South African Museum (vol. xiii., part 4), published in April, is filled with a paper by Mr. M. Connolly, on South African Mollusca, which he modestly entitles "Notes." The most important of these is a mongraph of the Dorcasiinæ—a distinctively tropical and South African subfamily of snails, which are fully described, with anatomical details, and a suggestive distributional discussion in which the author supports the theory of an ancient tropical continental tract stretching from South America by Africa and the Indian Ocean to Australia.

The last number (vol. xii., No. 76) of the Quekett Microscopical Club's Journal contains an account by Mr. R. T. Lewis of the early history of the club, which, founded on July 7th, 1865, has just celebrated its fiftieth birthday. Its first president was Dr. E. Lankester, and among his successors may be mentioned T. H. Huxley, W. B. Carpenter, A. D. Michael, and B. T. Lowne. Prof. A. Dendy now occupies the chair of the club, and his suggestive address on the biological conception of individuality is printed in the same number. The complexity and difficulty of the subject is well illustrated by his references to the well-known "border" cases of the Siphonophora, Cestoda, Annelida, and the communities of social insects, as well as to abnormal instances of "double personality" in human beings.

We have received the first number of vol. ix. of the *Quarterly Journal of Experimental Physiology*. It scarcely seems that it is as much as eight years ago that Sir Edward Schäfer founded this new physiological journal, and we wished it good-speed. The publication retains the high standard insisted upon by its editor, and the present number, among the interesting papers which it contains, is specially noteworthy as showing the activity of physiological laboratories in British dominions beyond the seas. One of these comes from Winnipeg, and deals with vasomotor reflexes (by Prof. Swale Vincent and Dr. A. T. Cameron); the other is by Prof. Jolly, of the South African College, Cape Town, and treats of the electro-cardiogram; in his attempt to unravel the meaning of the component parts of the curve he makes the interesting suggestion, and supports it by experimental arguments, that the two phases of metabolism (anabolism and katabolism) which have opposite electrical expressions are responsible for the alternating direction of the variations seen in the electro-cardiogram. Both Profs. Swale Vincent and Jolly are former assistants in Sir Edward's department at Edinburgh.

THOSE interested in the study of spiders, and of Indian spiders in particular, will welcome the first of what is intended to be a long series of "Notes on Indian Mygalomorph Spiders" in the Records of the Indian Museum, vol. xi., part 3, by the assistant superintendent of the museum, Mr. F. Gravely. The author makes stimulating comments on the Ischnocoleæ of the subfamily Aviculariinæ, so well represented in the Indian Peninsula, since from their many primitive characters they afford an insight into many evolutionary problems which yet await investigation. The Indian genera of this group seem to present a marked sexual dimorphism, all the known males being distinguished by the more or less extensive and conspicuous development of white hair on the feet, especially the anterior ones. His views on nomenclature and certain aspects of systematics seem to be yet in a state of flux.

ALL who are in any way concerned with the problems of economic ornithology, or of pisciculture, should read the report of Mr. P. A. Taverner on the "Double-crested Cormorant (*Phalacrocorax auritus*), and its Relation to the Salmon Industries on the Gulf of St. Lawrence," issued by the Canada Department of Mines (Biological Series No. 5, April, 1915). It is one of the most admirable summaries of its kind ever issued, and is the result of an inquiry instituted by the Geological Survey into the complaints of those interested in the salmon fisheries of the destruction caused to the fisheries by the ravages of the cormorants. The full account of a prolonged and impartial investigation is given in this bulletin, and the verdict arrived at shows conclusively that the harm attributed to this bird is absolutely without foundation. The author shows that while a small percentage of parr are undoubtedly eaten by cormorants, the bulk of the food of these birds is furnished by far less agile fish, having for the most part no economic value. The greatest enemies of young salmon, in the rivers, are older salmon, and the greatest toll on their numbers is taken during their sojourn in the sea by enemies which have yet to be determined. A precisely similar charge was levelled, some years ago, against the cormorants of the Murray River in Australia, where, to increase the salmon supply, a huge colony of cormorants was wiped out. But the unexpected happened. The salmon disappeared with the birds. It was then found that the latter had been feeding on crabs and eels, which in turn fed upon salmon eggs and fry. With the extermination of their enemies they increased in such numbers that scarcely a salmon egg remained, the fry from such as did escape were eaten by the eels. Those responsible for the massacre of the cormorants are now repentant!

In the *Philippine Journal of Science* (vol. x., Sec. C, No. 2, March, 1915) Mr. E. D. Merrill publishes the second instalment of his "Studies on Philippine Rubiaceæ." The paper consists of critical notes on the genera Mycetia, Chasalia, Psychotria, and Grumilea in particular, with descriptions of forty-two new species in various genera. The genus Pravinia, hitherto known from Borneo and Celebes with two species in each locality, is now found to be represented in Negros, Philippines, by a new species, *P. everettii*. Some ninety distinct species of the genus Psychotria are already known from the islands.

MR. Y. TOKUGAWA contributes a paper on the physiology of pollen to the Journal of the College of Science, Imperial University of Tokyo, vol. xxxv., December 17, 1914, a copy of which has just reached us. He finds that suitable osmotic pressure and suitable nourishment are essential for the growth of the pollen tube, and that cane-sugar alone is not sufficient for its growth. Among inorganic salts those of the heavy metals are more injurious than those of the lighter to the growth of the pollen. The pollen tube finds its way to the canals of the style and to the micropyle owing to the presence of a chemotropic substance. A fact of interest which is brought out is that the pollen grains of monocotyledons can germinate on the stigmas of dicotyledonous plants, and *vice versa*, though pollen grains frequently fail to germinate on the stigmas of plants nearly related to those whence the pollen was obtained.

Science for May 28 contains an interesting paper on disease resistance in plants, being a lecture delivered by Dr. Otto Appel, of Berlin, at various universities in the United States in October, 1914. The author points out that disease in plants is usually combated by killing the parasite before it enters the host, but the main theme of the lecture concerns the control of disease by breeding disease-resisting plants. As illustrations of the latter method of control, the breeding of rust-resistant wheats, the introduction of *Coffea robusta* as a plant less susceptible to attacks of *Hemileia vastatrix*, and the grafting of the European vine on resistant American stocks in dealing with Phylloxera are cited among other cases. There is no mention in the paper of the extensive work on wheats undertaken successfully by Prof. Biffen at Cambridge to produce immune varieties of wheat, nor is Dr. Appel's statement correct that rust has disappeared with the destruction of Barbery bushes, since the summer or uredo-spores have been found capable of surviving the winter and infecting the young wheat in spring. Breeding from plants possessing mechanical or other advantages tending to prevent the attacks of fungi is, however, as Dr. Appel suggests, likely to prove one of the most fruitful methods of controlling disease in plants.

THE Journal of the Royal Horticultural Society (vol. xl., part 3) contains several useful horticultural papers, and one of particular interest on the double stock, its history and literature, by Miss E. R. Saunders. The double stock is referred to first by Dodoens in 1568, and is figured by de l'Obel in 1581. Speculations as to the origin and mode of production of double stocks have been varied and frequent, and it is only owing to the Mendelian methods of analysis that light has been thrown on the subject. It appears that there are two fundamentally distinct types of single stocks—one of which gives rise only to single stocks, and the other which yields both doubles and singles, the proportion of doubles being from 53–57 per cent. How the doubles arose from the race of singles some two hundred and fifty years ago is unknown, but the ratio of doubles to singles yielded by these singles appears to be constant for all strains. In these ever-sporting singles it has been proved that all the pollen grains and some of the ovules lack a factor which produces singleness, and by the mating of such deficient pollen grains and ovules together the double-flowered form results. It has further been found that the double-flowered seedling grows more strongly than that of the single-flowered plant.

AN official guide to the Botanic Gardens, Dominica, has recently been issued (price 6*d*.), to which we would direct the particular attention of all interested in botany and in the tropical economic products of the world. The guide consists of some forty-four pages, with a good index, a map of the gardens, and a number of interesting illustrations. The area under cultivation is now about 60 acres, and consists of the garden proper of 44 acres, with experiment grounds and nurseries. In the latter are raised the lime, cacao, mango, Para rubber, coffee, and other plants, which are supplied at cost price to the planting community, and it is here that the grafting of cacao, limes, etc., and other experiments are carried out which have made the Dominica Gardens renowned. To the botanist, however, the garden proper is the more important feature. Here may be seen a multitude of interesting and useful trees and shrubs remarkably well grown and displayed, and in the guide particulars of the various plants and notes on their economic value are given. In 1892, a year after the garden was formed, Mr. Joseph Jones was sent out from Kew, and has now been curator for thirty-three years. It is to his skill and devotion that Dominica now possesses for its size one of the finest tropical botanic gardens in the world. Mr. Jones is to be congratulated on having produced so excellent and useful a guide, which will be much appreciated.

DURING the past seven years the Canadian Government has published several reports on the peat bogs of the Dominion and the efforts it has made to develop the peat industries (*v.* Nos. 30, 71, 151, and 154). A report now before us ("Investigations of the Peat Bogs and Peat Industry of Canada, 1911–12," by A. v. Anrep; Department of Mines, Canada, No. 266, Bulletin No. 9) deals with the amount and the quality of the peat contained in nine bogs situated along the line of the River St. Lawrence in the province of Quebec. It gives surface and section-maps of the bogs, and includes a detailed examination of the quality of the peat over the whole range of the bogs, which cover an area of about 34,000 acres. The portions of the various bogs suited for the manufacture of peat-moss litter on the one hand, or peat fuel on the other, are indicated on the maps which accompany the report. The author also considers in detail the engineering and commercial problems connected with the utilisation of the peat in the case of each bog. Although the report is primarily of local interest, one cannot fail, on reading it, to be struck with the contrast between the thoroughness with which the Canadian Government is grappling with the peat question and the apathy of the Irish Government towards the same problem. Interesting statistics of the peat industries of Sweden, Denmark, Holland, and Russia are given. Apart from the fact that Russia uses from 2½ to 4 million tons of peat fuel yearly, it is of some interest, especially to Irishmen, to learn that the Holmgaard factory at Naestved, in Denmark, uses about 5000 tons of peat briquettes yearly in the manufacture of glass.

THE Royal Observatory at Hong-Kong has issued its report for 1914, dealing with meteorological, magnetic, and time observations. The principal features of the weather during the year are said to be the absence of violent typhoon winds, the relatively high temperature in January, February, and March, and excessive rains in July, September, and November, with a relatively dry August, and a rainless January. The highest temperature was 94° on August 31, compared with 97° for the previous thirty-one years, and the lowest temperature was 47° on January 1, compared with 32° in previous records. July was by far the wettest month, with a rainfall of 26·31 in., and the total for the year was 100·22 in. The greatest wind velocity for any hour was forty-two miles on September 3, and the greatest squall velocity on the same day was at the rate of forty-eight miles an hour. A map of the Far East and the Daily Weather Report is regularly issued, containing observations from about forty stations in China, Indo-China, Japan, and the Philippines. A daily weather forecast is also given for Hong-Kong and district, the Formosa Channel, the south coast of China between Hong-Kong and Hainan, and the south coast of China between Hong-Kong and Lamocks.

THE recently published *Compte rendu* of the Physical and Natural History Society of Geneva for the year 1914, shows that the activities of the society have not been seriously affected by the war. The society consists of sixty-six ordinary members and about the same number of honorary and free members. The scientific papers for the year cover sixty-four pages, and are chiefly devoted to physics. Amongst the most important are Prof. Tommasina's contributions to theoretical physics, mainly criticising the theory of relativity, and the measurements of the electronic charge by MM. Schidlof and Karpowicz. Using drops of mercury of radii between 10^{-4} and 10^{-5} centimetre produced by an atomiser, they find that the light falling on the drops causes an appreciable amount of evaporation, and in consequence a variable speed of fall in a constant electric field. They also find that Cunningham's expression for the speed of fall of drops is not applicable to drops of the size used. The experiments, which are not yet complete, lend no support to the contention of Ehrenhaft that electrical charges exist, not integral multiples of the electron.

An important paper on the preparation and digestive properties of papain is communicated from the laboratory of organic chemistry, Bureau of Science, Manila, by Mr. David S. Pratt; it is published in the *Philippine Journal of Science* (vol. x., p. 1). Papain is the name given to the proteoclastic enzyme elaborated by *Carica papaya*, L., and is secreted in the milky latex that forms a prominent characteristic of the plant. The methods in use for preparing and drying the latex are described in some detail, and its digestive activity studied; suggestions are made for standardising the methods of evaluation. Although the market is in a way a limited one, the possibility of establishing a papain industry in the Philippine Islands should receive attention, as it does not necessitate a large investment of capital, and the time required is short before returns may be expected.

Science Progress for July contains papers on the structure of the universe by Mr. H. Spencer Jones (see Nature, July 15, p. 548), on the molecular structure and mode of oxidation of carbon, by Mr. Maurice Copisarow; on the *rôle* of reductase in tissue respiration, by Profs. D. F. Harris and H. J. M. Creighton; on some eugenic aspects of the war, by Mr. A. G. Thacker; and on the spinning properties of cotton, by Mr. W. Lawrence Balls. A short paper by Mr. S. C. Bradford gives the history of adrenalin, the active principle of the suprarenal capsules; the story of the discovery of their function, followed by the isolation of the active principle, the determination of its structure, and its subsequent synthesis, is one of the most fascinating chapters in the history of biochemistry and in the application of modern organic chemistry to therapeutics. The present number of *Science Progress* contains a novel feature in the form of short reports by various specialists on recent advances in science. These reports are to be continued every quarter, and should prove not one of the least valuable features of our contemporary.

OUR ASTRONOMICAL COLUMN.

Astrographic Catalogue, Perth Section.—The Perth Observatory of Western Australia was assigned a region of the sky for the construction of the great Astrographic Catalogue distributed among observatories situated all over the world. The section which was undertaken was that lying between 31° and 41° of south declination. The publication of the volumes containing the measures will be issued in thirty-six volumes, each containing six hours of right ascension for one degree of declination, but the volumes will not necessarily be published in numerical rotation. Under the direction of the Acting Government Astronomer, Mr. H. B. Curlewis, four volumes of measures have recently been issued, and these cover the regions summarised in the following table:—

Vol.	Right Ascension h. h.	Dec. of centre of plate °	Number of stars
IX.	0–6	−34	6,262
X.	6–12	−34	22,475
XI.	12–18	−34	20,498
XII.	18–24	−34	14,793

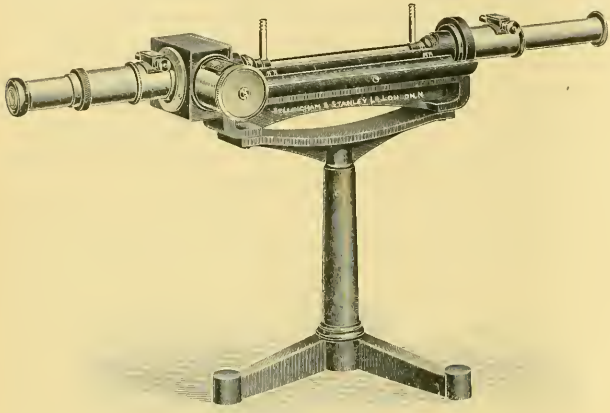
Issued with these volumes is vol vi. of the meridian observations containing a catalogue of 2025 stars between 37° and 39° south declination. These stars were selected as reference points for the Astrographic Catalogue, and are distributed approximately at the rate of three per square degree. Another volume consists of tables prepared for use in connection with zones 32° to 40° south declination. These tables are published in order that they may be readily accessible to those who are working in these zones. They are for the conversion of R.A. and declination, into standard conductors and of standard co-ordinates into R.A. and declination for plates having their centres in each of the above-mentioned degrees.

The Scintillation of Stars.—A valuable article on the scintillation of stars and the unsteadiness ("boiling") of the instrumental image is contributed by M. G. Bigourdan, of the Paris Observatory, to the Bulletin of the French Astronomical Society (June). M. Bigourdan attempts to demonstrate their identity. In comparing the two phenomena the effect of stellar type, aurora borealis, and magnetic perturbations, barometric pressure, proximity of clouds, influence of azimuth, and of twilight, are separately considered. There are no data regarding effect of azimuth on tremor of image, and the effect of twilight appears to be to *increase* scintillation and decrease boiling, otherwise the two phenomena, it is concluded, present a true parallelism. Double-star observers are recommended to keep records of the degree of scintillation.

The University Observatory, Oxford.—The fortieth annual report of the Savilian professor of astronomy shows that the activity of this institution has been well maintained during the period 1914–15. The analysis of meteorological statistics in pursuit of periodicities has been continued, and a cycle of 41–2 years has been traced in rainfall, etc.; in this direction there has been opened up an unlimited vista of work. The director has continued to control the earthquake station at Shide, and very pertinently suggests that the work of the Oxford University might well be extended in the direction of geophysics. In connection with the International Chart several Belgians resident in Oxford have rendered assistance in the measurement of star photographs. The distribution of stars according to magnitude has been determined for the Oxford, Bordeaux, Algiers, Cape, and Perth zones. Regional differences in the ratio of faint to bright stars thus revealed suggest the local presence of obscuring matter, and, when due allowance is made for this phenomenon the ratio seems to vary to a slight extent with galactic latitude.

A NEW SACCHARIMETER.

ONE of the many optical instruments which the English opticians have allowed the Germans to supply almost entirely is the saccharimeter. This instrument used to be made by Browning, but in late years nearly every instrument purchased in England has come from Berlin from the firm of Schmidt and Haensch, who make several designs of large and small instruments. It is therefore a pleasure to find an English firm—Messrs. Bellingham and Stanley, of London—making a saccharimeter which introduces valuable improvements on the German design. The one to which we refer is of the half-shadow type with quartz compensating wedges, but instead of the usual long wedge of which the movement is read direct by a scale and vernier, this one has a short wedge of larger angle. The wedge is moved by a screw, and the movement is read on a large drum with an open scale and sliding pointer.



New short-wedge saccharimeter.

The whole length of the scale is some 2 ft. instead of $1\frac{1}{2}$ or 2 in., and it can thus be read with great ease.

In instruments making use of a quartz wedge of the usual length (about 3 cm.), the scale is nearly always uneven, and unless calibrated introduces errors amounting to several tenths of a degree Ventzke. According to Landolt this is due to the quartz, which he describes as "a poor material optically"; he says that one seldom finds faultless plates, and that a pure wedge 3 cm. long is rare. Hence the value of the short wedge of Bellingham and Stanley which is less than half the usual length. The advantage of such a wedge, even if the quartz is not of special quality, is greater than would appear at first sight, since the field is due to the *average* effect of the whole of the light passed through the wedge, and this average will vary evenly through the small change of area of the wedge due to its movement, and thus the scale will be regular in spite of variations in the quartz; also it is easier to get repeated readings, owing to the greater ease with which the setting can be made with the fine adjustment given by the series, as compared with the usual rack and pinion motion. In fact, the makers state that they have not detected any calibration errors in their instruments.

Another valuable feature is the enclosure of the scale and all working parts, so that they are protected from the salt vapours. The importance of this needs no emphasis to those who have had experience with instruments of this character. The corrosion of the

Scale of saccharimeter.

metal work—especially steel work—and of the scale, when as in the higher priced instruments this is engraved on silver or nikelin, under the action of the fumes in a laboratory often renders the instrument almost unusable in a few years. The instrument is mostly constructed of an aluminium alloy, protected by a black-stoved enamel, and no steel is used except for a small spring, which is entirely enclosed.

The optical work is of the first quality. The dividing line is sharp and clean, and the field evenly illuminated, so that adjustment for equality can be made without ambiguity, and with corresponding accuracy. The makers calibrate the scale at a number of points by direct reading against a polariser rotated on a divided circle. In the instrument examined the divisions were in half degrees "Ventzke" (of which 100 correspond to 34·68° of arc, for sodium light at 17·5° C.), and it was easy to estimate to tenths of a degree, *i.e.* to less than three minutes of arc. The design and workmanship were all that could be desired.

The same firm is also making refractometers of the Abbe and Pulfrich type and other optical instruments.

OUR OVERSEAS MUSEUMS.

THE British Museum, the parent and model of the museums scattered throughout our Empire, stands alone in that it has no journal of its own wherein to record the work done by its staff, though from time to time special memoirs and reports are published by the Trustees. There is much to be said for the publication of a museum journal, and not the least important of its functions would be to afford the general public an index of the magnitude and scope of its work, which can now only be estimated by laborious compilation from the annual "blue-book" or the publications of the various learned societies.

A measure of the nature of the work performed by the staff of a properly organised museum can be gauged by a survey of the journals and "records" relating to the museums of our colonies and of our Indian Empire. For the most part the contents of such journals are of necessity of a highly technical character, as, for example, the series of papers in the "Records of the Indian Museum" for April. If any of these are to be chosen for special mention it must be the profusely illustrated "Contribution to a Knowledge of the Terrestrial Isopods of India," by Mr. W. E. Collinge, describing a collection of species new to science from the Madras Province of Southern India.

The *Journal* of the Federated Malay States Museums for March contains a valuable paper on the zoology of Koh Samui and Koh Pennan by Messrs. H. C. Robinson and C. Boden Kloss, and another on the plants therefrom by Prof. H. N. Ridley; while the April number contains a most interesting summary of Malay filigree work by Mr. I. H. N. Evans.

The thirteenth report of the Sarawak Museum contains a complete list of all the mosquitoes known from Borneo. The material for this was collected by the curator, Mr. J. C. Moulton—now on active service in France—and determined by Mr. F. W. Edwards, of the British Museum.

The Report of the South African Museum contains a brief summary of the acquisitions of the Geological Department, some of which are of considerable importance, as, for example, the remains of a small dinosaur from Bushmanland, apparently allied to the Cretaceous dinosaurs, and which throw light on the age of the old land surface in the north-west of the Cape Province.

The Records of the Albany Museum for May contains seven papers, one of which, on the fleas infesting various wild South African mammals, may prove of more importance than would appear at first sight.

All these institutions appear to be in a flourishing condition, but this is evidently far from true of the Rhodesia Museum, Bulawayo, which, in its thirteenth annual report, complains bitterly of the lack of funds. So seriously has its income fallen off that it has been necessary not only to reduce its staff, but to suspend even work necessary to ensure the well-being of the collections. We trust that better days are in store for the Albany Museum.

ENTOMOLOGICAL WORK IN CANADA.

RECENT publications of the Entomological Branch of the Canadian Department of Agriculture illustrate the wide field of the activities of Dr. Gordon Hewitt and his staff and the advances they are making in our knowledge of the control of insects.

In the *Canadian Entomologist* for March, 1915, Dr. Hewitt discusses the hibernation of the house-fly in a paper that is of very great topical value at the moment in this country; he finds that the maggots pupate at depths up to 2 ft. below and away from a manure heap, where this is situated on sandy loam; he finds also that the flies emerge from this situation. Discussing the hibernation of the insect, he reiterates his belief that it is as the adult that they live over the winter in northern latitudes.

In the Transactions of the Royal Society of Canada for September, 1914, Dr. Hewitt describes observations on the feeding of the stable-fly, *Stomoxys calcitrans*, which will be of value to those seeking to fix the rôle this insect plays in the dissemination of disease, notably of infantile paralysis.

A circular of the Department of Agriculture contains the instructions to importers of trees, plants, and other nursery stock into Canada; it explains clearly and simply what the importer has to do, and reprints the text of the Act. Another circular deals with the control of locusts in eastern Canada; the author, A. Gibson, uses the term locust for grasshopper, whereas it is better restricted to the migratory grasshoppers; but the circular is for popular use, and the term is probably so used in eastern Canada.

The most interesting point is the value of adding lemon juice to the poisoned bait for killing the insects; the method originated in Kansas, and works well in Canada.

In Bulletin No. 9 Mr. Gibson deals with the Army worm *Cirphis unipuncta*, an insect which caused a loss of 50,000*l*. in Ontario alone. He emphasises the great importance of co-operation among farmers in dealing with outbreaks promptly and thoroughly by means of trenching, poisoning, and rolling. It is possible that something better could be done with moth trapping on the "Andres Maire" system, which has proved successful elsewhere. The bulletin is a thoroughly practical, useful piece of work, and the Department evidently has the confidence of the farming community in Canada. H. M. L.

THE SUPPLY OF OPTICAL GLASS.

THE subject of the supply of optical glass and the needs and opportunities offered to the optical trade, by war and after-war conditions, still continues to attract the attention which it deserves. On July 16 an important conference was held at the London Chamber of Commerce between the Court and representatives of the Spectacle Makers' Company and representatives of the chamber and of the trade. The conference was convened by the company, and the chair was taken by the master, Sir J. F. L. Rolleston, M.P. There were also present Lord Southwark, president of the Chamber of Commerce, Viscount Hill, Sir William Hart Dyke, Sir Marcus Samuel, Dr. R. M. Walmsley, and others. The chairman opened the proceedings, and in the course of his speech explained how the debate in the House of Commons on optical matters which was initiated by Sir Philip Magnus on May 19, and in which several well-informed members, including the chairman, were prepared to take part, was interrupted and practically closured by the Prime Minister's very important announcement on "Coalition Government." He also referred to various matters to which we have directed the attention of our readers as they arose.

Lord Southwark, in opening the discussion, referred to the fact that he was not only the president of the chamber, but also a past-master of the Skinners' Company, which is so closely associated with the Northampton Polytechnic Institute and its work. He emphasised the importance of concerted action and the help which the City companies could give, and referred also to the valuable assistance which could be rendered by the chamber. In the discussion which followed, it was understood that the remarks made by trade members should not be reported. Dr. Walmsley, who was called upon to speak early in the debate, explained the points referred to in his letter to the *Times* of April 28, and indicated the importance of the opportunities which have now arisen for the recapture of those branches of the optical instrument trade which were so heavily handicapped before the war. He pointed out that this was worthy of a very earnest effort, and he referred particularly to the value of the trade in the employment of highly skilled labour, which forms so important an item in the production of complicated optical instruments, such as microscopes, etc. He also dwelt upon the necessity for training designers and computers. The importance of the spectacle-making branch of the trade was fully insisted upon, and eventually it was decided, on the motion of Lord

Southwark, at the suggestion of Sir William Hart Dyke, to appoint a joint committee of the Spectacle Makers' Company and the London Chamber of Commerce to study the questions at issue in all their bearings.

THE GOVERNMENT SCHEME FOR THE ORGANISATION AND DEVELOPMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

WE gave in our issue of May 20 a detailed report of speeches made in the House of Commons when the Government scheme for the formation of an Advisory Council concerned with industrial and scientific research was outlined by Mr. J. A. Pease, then President of the Board of Education. Since that time Mr. Arthur Henderson has succeeded Mr. Pease at the Board, and he has just issued as a White Paper (Cd. 8005, price ½*d.*) a statement of the need and nature of a scheme which will secure scientific foundations for national industries in the future. The paper is here reprinted.

(1) There is a strong consensus of opinion among persons engaged both in science and in industry that a special need exists at the present time for new machinery and for additional State assistance in order to promote and organise scientific research with a view especially to its application to trade and industry. It is well-known that many of our industries have since the outbreak of war suffered through our inability to produce at home certain articles and materials required in trade processes, the manufacture of which has become localised abroad, and particularly in Germany, because science has there been more thoroughly and effectively applied to the solution of scientific problems bearing on trade and industry and to the elaboration of economical and improved processes of manufacture. It is impossible to contemplate without considerable apprehension the situation which will arise at the end of the war unless our scientific resources have previously been enlarged and organised to meet it. It appears incontrovertible that if we are to advance or even maintain our industrial position we must as a nation aim at such a development of scientific and industrial research as will place us in a position to expand and strengthen our industries and to compete successfully with the most highly organised of our rivals. The difficulties of advancing on these lines during the war are obvious and are not under-estimated, but we cannot hope to improvise an effective system at the moment when hostilities cease, and unless during the present period we are able to make a substantial advance we shall certainly be unable to do what is necessary in the equally difficult period of reconstruction which will follow the war.

(2) The present scheme is designed to establish a permanent organisation for the promotion of industrial and scientific research.

It is in no way intended that it should replace or interfere with the arrangements which have been or may be made by the War Office or Admiralty or Ministry of Munitions to obtain scientific advice and investigation in connection with the provision of munitions of war. It is, of course, obvious that at the present moment it is essential that the War Office, the Admiralty, and the Ministry of Munitions should continue to make their own direct arrangements with scientific men and institutions with the least possible delay.

(3) It is clearly desirable that the scheme should operate over the kingdom as a whole with as little regard as possible to the Tweed and the Irish Channel. The research done should be for the kingdom as a whole, and there should be complete liberty to utilise the most effective institutions and investigators available, irrespective of their location in England, Wales, Scotland, or Ireland. There must therefore be a single fund for the assistance of research, under a single responsible body.

(4) The scheme accordingly provides for the establishment of:—

(*a*) A Committee of the Privy Council responsible for the expenditure of any new moneys provided by Parliament for scientific and industrial research;

(*b*) A small Advisory Council responsible to the Committee of Council and composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research.

(5) The Committee of Council will consist of the Lord President, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education (who will be vice-president of the Committee), the Chief Secretary for Ireland, together with such other Ministers and individual Members of the Council as it may be thought desirable to add.

The first non-official members of the Committee will be:—The Right Hon. Viscount Haldane of Cloan, O.M., K.T., F.R.S., the Right Hon. Arthur H. D. Acland, and the Right Hon. Joseph A. Pease, M.P.

The President of the Board of Education will answer in the House of Commons for the sub-head on the Vote, which will be accounted for by the Treasury under Class IV., Vote 7, "Scientific Investigations, etc."

It is obvious that the organisation and development of research is a matter which greatly affects the public educational systems of the kingdom. A great part of all research will necessarily be done in universities and colleges which are already aided by the State, and the supply and training of a sufficient number of young persons competent to undertake research can only be secured through the public system of education.

(6) The primary functions of the Advisory Council will be to advise the Committee of Council on:—

(i) Proposals for instituting specific researches;

(ii) Proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades;

(iii) The establishment and award of research studentships and fellowships.

The Advisory Council will also be available, if requested, to advise the several Education Departments as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research.

Arrangements will be made by which the Council will keep in close touch with all Government Departments concerned with or interested in scientific research and by which the Council will have regard to the research work which is being done or may be done by the National Physical Laboratory.

(7) It is essential that the Advisory Council should act in intimate co-operation with the Royal Society and the existing scientific or professional associations, societies, and institutes, as well as with the universities, technical institutions, and other institutions in which research is or can be efficiently conducted.

It is proposed to ask the Royal Society and the principal scientific and professional associations, societies and institutes to undertake the function of initiating proposals for the consideration of the Advisory Council, and a regular procedure for inviting and collecting proposals will be established. The Advisory Council will also be at liberty to receive proposals from individuals and themselves to initiate proposals.

All possible means will be used to enlist the interest and secure the co-operation of persons directly engaged in trade and industry.

(8) It is contemplated that the Advisory Council will work largely through Sub-Committees reinforced by suitable experts in the particular branch of science or industry concerned. On these Sub-Committees it would be desirable as far as possible to enlist the services of persons actually engaged in scientific trades and manufactures dependent on science.

(9) As regards the use or profits of discoveries, the general principle on which grants will be made by the Committee of Council is that discoveries made by institutions, associations, bodies, or indviduals in the course of researches aided by public money shall be made available under proper conditions for the public advantage.

(10) It is important in order to secure effective working that the Advisory Council should be a small body, but it is recognised that even if full use is made by the Council of its power to work through reinforced Sub-Committees, its membership may be found inadequate to do justice to all the branches of industry in which proposals for research may be made or to the requests of other Government Departments for assistance. It is therefore probable that it will be found necessary to strengthen the Council by appointing additional members.

The first members of the Council will be:—The Right Hon. Lord Rayleigh, O.M., F.R.S., Mr. G. T. Beilby, F.R.S., Mr. W. Duddell, F.R.S., Prof. B. Hopkinson, F.R.S., Prof. J. A. M'Clelland, F.R.S., Prof. R. Meldola, F.R.S., Mr. R. Threlfall, F.R.S., with Sir William S. M'Cormick as administrative chairman.

(11) The Advisory Council will proceed to frame a scheme or programme for their own guidance in recommending proposals for research and for the guidance of the Committee of Council in allocating such State funds as may be available. This scheme will naturally be designed to operate over some years in advance, and in framing it the Council must necessarily have due regard to the relative urgency of the problems requiring solution, the supply of trained researchers available for particular pieces of research, and the material facilities in the form of laboratories and equipment which are available or can be provided for specific researches. Such a scheme will naturally be elastic and will require modification from year to year; but it is obviously undesirable that the Council should live "from hand to mouth" or work on the principle of "first come first served," and the recommendations (which for the purpose of estimating they will have to make annually to the Committee of Council) should represent progressive instalments of a considered programme and policy. A large part of their work will be that of examining, selecting, combining, and co-ordinating rather than that of originating. One of their chief functions will be the prevention of overlapping between institutions or individuals engaged in research. They will, on the other hand, be at liberty to initiate proposals and to institute inquiries preliminary to preparing or eliciting proposals for useful research, and in this way they may help to concentrate on problems requiring solution the interest of all persons concerned in the development of all branches of scientific industry.

(12) An Annual Report, embodying the Report of the Advisory Council, will be made to his Majesty by the Committee of Council and laid before Parliament.

(13) Office accommodation and staff will be provided for the Committee and Council by the Board of Education.

MODERN MUNITIONS OF WAR.[1]

I.—GUNS AND PROPELLANTS.

ELEVEN months of war have now passed, and certain lessons have made themselves perfectly clear. The teaching of the first six months of the war was tersely summed up by General French when he said last February, "The problem set is a comparatively simple one—munitions, more munitions, always more munitions," the special munitions meant in this case being the high explosive shells that from the time the war assumed the conditions of a field siege after the battle of the Aisne became a necessity for any advance.

By "munitions" are meant practically everything required by the Army, and it will be well first to consider the wonderful changes which have taken place in guns and propellants, and which in this war have made artillery probably the most important feature.

Napoleon, himself an artillery officer, was fond of using massed batteries in much the same way as artillery is being used in the present war, but what artillery meant in those days and in these can perhaps be best grasped by remembering that the old *Victory*, which was our most heavily armed ship in the Napoleonic days, had a broadside of 52 guns, which, when fired simultaneously, would have thrown about 60 per cent. of the weight of the metal contained in one shot from the 15-in. guns of the modern super-Dreadnoughts. We must also remember that in the Crimean War the old smooth-bore 68-pounders, using a charge of 16 lb. of black powder, were the largest guns ashore or afloat at the time, whereas now we have the 15-in. guns of our super-Dreadnoughts, weighing close on 100 tons, from which a charge of 400 lb. of MD cordite hurls a projectile weighing 1925 lb. with accuracy to a distance of fifteen miles, or with high angle firing to double that distance.

The changes commenced in the 'fifties of the last century, when we adopted the idea of rifling ordnance so as on firing the gun to give the projectile a spin as well as forward velocity, this being found to add to the range and accuracy of fire, and in order to do this satisfactorily the guns had to be increased in length.

The rate at which the size of the big naval guns grew may be gathered from the fact that at the Siege of Alexandria in 1882 we had the 80-ton guns of 16-in. calibre, whilst by 1886 we had afloat the 110-ton guns with a bore of 16·25 in., using a charge of 960 lb. of powder. It was soon found, however, that the lengthening of the gun when using the form of gunpowder then employed caused a strain on the breech and gave but a low muzzle velocity, this being due to the rapid burning of the powder. Attempts were then made to slow the combustion of the powder by increasing the size of the grain, and with the increase in the size of the guns the powder gradually grew to the large pebble powder, consisting of $1\frac{3}{4}$-in. cubes. Unfortunately the desired effect could not possibly be obtained by alterations of this character, as it is required of a perfect powder that when the charge is fired in the breech of the gun, the combustion shall commence comparatively slowly, so as to overcome the *vis inertiae* of the projectile without throwing too great a strain on the gun, and the combustion of the powder should then increase in rapidity so as to supply gas more and more rapidly to increase the pressure and momentum of the shot, which should leave the muzzle of the gun with the maximum velocity.

With such forms of powder as cubes or other large

[1] Abstracts of three lectures delivered at the Royal Society of Arts on July 7, 14, and 21, by Prof. Vivian B. Lewes.

grain, however, maximum rapidity of burning and evolution of gas takes place at first, owing to the ignition spreading over the whole surface of the cubes, and instead of the gas coming off with more and more rapidity as the space in the gun became larger, the evolution rapidly diminished with the decrease of surface caused by the burning away of the powder.

In order, so far as possible, to avoid this defect, built-up charges were resorted to, and it was General Rodman, of the American Service, who first tried to overcome the difficulty by building up the charge of solid slabs perforated with holes, from the interior of which the combustion was started, so as to expose the minimum surface of powder at first, whilst the enlarging holes produced a greater and greater surface of powder as the space behind the projectile increased.

Large perforated cakes, however, are always liable to break, and cannot be made of uniform density, so that it was found far better to mould the powder into hexagonal prisms with a central core through them, which could be built up into a charge, the prisms being made with such exactitude that when the charge was fired by a layer of fine grain powder at the base of the cartridge the combustion started from the central cores, and as the powder burnt away a greater and greater surface for combustion was continually formed until the whole of the charge was spent.

With the continued growth, however, in the size of the guns employed other changes became necessary, as even when using the black prism powder for built-up charges the pressure given began to throw too severe a strain upon the breech of the gun, even when the cartridges were made up in such a way as to leave air spaces at the seat of the charge. In order to relieve the initial pressure so far as possible, and to secure further modifications, alterations in the composition of the powder became necessary, so that by the time the 80- and 110-ton guns were introduced into the Naval Service prism powder containing an increased percentage of potassium nitrate and charcoal with a smaller proportion of sulphur were in use.

This fitting of the powders to the guns enabled perfect ballistics to be obtained, and really converted the explosive into what Sir Frederick Nathan was fond of calling these powders—"propellants." These powders had one characteristic, however, in common with the old grain powder, and that was that they gave volumes of smoke, and when rapid-firing guns were introduced so dense was the cloud produced that after the first few rounds nothing could be seen, and the guns became useless until the smoke had cleared. This rendered a smokeless powder a necessity, and the history of the inception of the smokeless powders of to-day is full of interest.

In any successful explosive certain conditions have to be fulfilled; one must be able to concentrate in a small space bodies which will act upon each other independent of the air with enormous rapidity, forming the largest possible volumes of gas, which, expanded by the heat of the action and having to find a way for itself, gives the explosive effect. If this change takes an appreciable time, the body can be used as a "propellant" in a gun, and gunpowder is of this character. When, however, the change takes place practically instantaneously, it cannot be used in a gun, and is used in high-explosive shells, bombs, torpedoes, and mines; and such bodies we call "high explosives," nitroglycerin being an example of this class.

When during the formation of the gas from the solid in explosion other solid compounds are formed as well, these solids are blown out in a fused form as fine particles and form a cloud-smoke, but, if only gases are produced, the explosion is smokeless. Gunpowder on being fired gives nearly half its weight as solids and therefore forms clouds of smoke; guncotton is resolved entirely into gases and gives no smoke.

When the necessity for a smokeless powder became urgent, it was naturally to nitro-cotton, discovered by Schonbein in 1845, that attention was most largely turned, but all attempts to convert it from an "explosive" to a "propellant" failed until it was discovered that its rate of combustion could be slowed down sufficiently to make an excellent propellant by destroying the original cotton structure that still existed in the nitro-cotton by gelatinising it with alcohol and ether, so forming a grain that can only burn from the exterior. If cotton fibre is examined under the microscope it is found to consist of very minute tubes, and in the process of converting the cotton into "guncotton," by soaking it in a mixture of the strongest nitric and sulphuric acids, washing out all acid and drying, this structure remains. If the guncotton were used as a charge in a big gun, no matter how much it was compressed, the flame of the combustion would be driven back into these tubes and so accelerate the burning as to give almost instantaneous explosion, straining the gun and giving very low velocity to the projectile.

Nitroglycerin is an even more rapid explosive than guncotton, and if used in a gun would burst it, probably without driving out the projectile at all. Nobel, however, in 1875 discovered that if a low form of guncotton was macerated in nitroglycerin the guncotton was gelatinised, all structure disappeared, and both explosives became so tamed in their action that they were converted into a perfect blasting explosive; and in 1888 the mixture was made the basis of a smokeless propellant far superior to gunpowder. This idea was improved upon by Sir Frederick Abel and Sir James Dewar, who found that the highest form of guncotton, which is unacted upon by nitroglycerin, could be got into a gelatinised mass with nitroglycerin if a common solvent, such as acetone, was used to blend them, and afterwards evaporated out, and this blend with 5 per cent. of vaseline to increase the stability and lubricate the gun forms our modern "propellant" cordite, so named from the fact that it is cast into sticks, rods, or cords, according to the size of the gun in which it is to be used.

The "Mark I" cordite first made contained 68 per cent. of nitroglycerin, and the heat of its combustion in the guns gave rise to a troublesome form of erosion, which in the South African war shortened the lives of the field guns, which had to be re-lined after a certain number of rounds had been fired, and this led to an alteration in the proportion of the ingredients in the MD cordite now used in all arms, from the 15-in. guns of our super-Dreadnoughts to the Service rifles.

Our Allies and enemies alike use smokeless powders of a somewhat different type, made by gelatinising nitro-cotton without any nitroglycerin for their field artillery and rifles, but in the German and Austrian naval guns nitroglycerin powders of much the same kind as our "cordite" are used, as a larger charge of nitro-cotton powder has to be employed than of a nitroglycerin powder, and this means larger chambers in the guns and larger magazines to carry the necessary amount of explosive.

As may be imagined, the introduction of smokeless powder made an immediate change in gun construction, as much smaller chambers were needed, and the possibility of throwing the pressures further forward in the gun enabled them to be made lighter, and as a result our biggest naval guns are only 15 in. as against the 16·25-in. 110-ton guns in use in 1886, and the charge of MD cordite only 400 lb. as against the 960 lb. of prism powder, but the muzzle velocity has increased by nearly 50 per cent., whilst the projectile is far heavier.

Our enemies in the field are using guns, howitzers and mortars, the two latter classes being used for indirect fire from behind shelter, for which their high trajectory specially fits them, whilst the field artillery used by them are chiefly quick-firing 77-millimetre guns (3·03 in.). One of the new features they have introduced into the present warfare is the use of siege guns of much larger size, transported by motors, and so made available for field work, whilst amongst the other artillery in use are the celebrated Krupp siege howitzers of 16·8 in. calibre, but probably the most deadly innovation has been the almost unlimited use of machine guns, to the perfecting of which the Germans have devoted many years, and of which they have an enormous supply.

II.—SHELLS AND HIGH EXPLOSIVES.

The shells used in big guns and field artillery may be divided into two main classes: shrapnel, which is utilised against troops in the field, and is of but little use against fortifications or trenches, and high explosive shells, which may be either armour-piercing or ordinary.

The shrapnel shell is a hollow cylindrical steel projectile packed with bullets, at the base of which is a bursting charge that may be gunpowder or high explosive, whilst in the nose of the shell is arranged the time fuse connected by a tube to the bursting charge, and so regulated that the shell can be exploded in the air at any desired point, the bullets and fragments of the shell being driven forward and spreading over a considerable area. The shrapnel used in the ordinary field gun is an 18-lb. projectile, containing 375 bullets, and when burst at the right altitude is a most deadly weapon against troops, especially when in massed formation. Since its invention by the officer whose name it bears, shrapnel has been looked upon in the Service as the form of shell most necessary in field operations, and during the present war our supplies have been ample for all requirements.

For fortified trench warfare, such as has been the characteristic feature of the fighting on the western front since September, shrapnel is not effective, as it does but little damage to earthworks, wire entanglements, and other defences, and this practically new phase of field warfare has to be met by the use of high-explosive shells, capable of detonating with such enormous concussive power as to destroy physical obstructions, crumble earthworks, clear wire entanglements, and reduce the defenders in the trenches to a dazed and stunned condition by the action of concussion on the heart and nerves.

Under the conditions created in the present war both classes of shells are needed in the field—the shrapnel to resist infantry attack, the high-explosive shells to clear the ground and prepare the way for attack on the enemy, and it has been an insufficiency in the supply of the latter which has given rise to so much criticism, mostly undeserved and wholly unwise. At the present time obstacles to supply in all directions have been surmounted, and a steady and ever-increasing stream of shell is flowing to the front.

The high-explosive shell is made of forged steel with comparatively thin walls and a heavy bursting charge, but the large naval shells and those for the siege guns, which have to penetrate heavy armour, are made from ingots of chrome or chrome-nickel steel, forged, hardened, and the nose capped with soft steel, which prevents the shell from shattering on impact with the hardened steel armour. These shells also contain a heavy charge of high explosive, generally cast into the shell in a fused condition.

All these forms of shell are fitted with the usual soft copper driving bands near the base of the shells; these bands take the place of the projections used in the early forms of shell to fit the rifling of the gun. The copper band, under the pressure existing during the firing of the charge, is pressed into the grooves of the rifling in the gun, not only imparting rotation to the projectile, but also acting as a gas check to prevent the rush of the gas past the projectile, an action which had accentuated the serious erosion with Mark I cordite.

For trench fighting the grenade has now again come into use, and the most modern forms are in reality miniature shrapnel shells, which are fitted on to a rod that can be fired from a rifle, or, where the trenches are close together, can be thrown or slung by hand. The body of the grenade is made of steel or malleable iron so serrated as to break up on explosion into many pieces; it contains a charge of T.N.T., and a tetryl detonator fired on impact by a needle liberated only after the grenade has travelled a certain distance, so as to render premature explosion impossible. The weight of such a grenade is about 23 oz., and when fired its range would be about 300 yards, but when hand-thrown not more than 40 or 50, and its flight through the air is steadied when fired by a rod, which for hand use is replaced by a rope tail.

One of the things that strikes the ordinary observer most when considering the composition of the explosives of to-day is that they are all derived from substances of the most commonplace and harmless description, and probably the greatest mistake the Government has made in this war was in not making cotton contraband from the commencement, and it is inexcusable that the mistake should not be rectified.

There is not the least doubt that Germany had enormous supplies of cotton at the commencement of the war, as well as huge quantities of manufactured explosive, but the factor which she had omitted to reckon on was the duration of the war, which was expected to be over last November. It has been calculated that Germany and Austria need 1000 tons of cotton a day, and it has been proved that the neutral European countries—Holland, Denmark, Sweden, and Norway—imported during the first three months of this year six times the amount they did in the corresponding period of last year, and there can be but little doubt as to where this enormous surplus went.

Directly there is any talk of making cotton contraband German articles appear in the Press of the neutral countries pointing out that it is not aimed at German explosives, but is England's attempt to corner the trade in textile fabrics, but for some inscrutable reason the Government has so far declined to do the one thing that more than any other would shorten the war.

We have seen that cotton and glycerin when nitrated and blended with vaseline yield cordite, which serves as a propellant in all our guns, whilst the high explosives used in shells, torpedo heads, mines, and aviators' bombs are almost entirely derived from coal-tar derivatives by nitration. When coal tar is subjected to fractional distillation the portion which comes over up to a temperature of 170° C. is called "light oil," and contains all the compounds of low boiling point found in the tar, and, as we shall see, from this several of our most valuable explosives can be obtained. When these light oils have distilled over the next fraction or "middle oil" yields phenol or carbolic acid, a body which when nitrated gives picric acid, the basis of the French high-explosive melinite, the Japanese shimose powder, and the English lyddite.

Picric acid is a nitro-substitution product, three atoms of the hydrogen of the original phenol being replaced by the radical nitryl, NO_2, and it forms with metals a class of salts called "picrates." The potassium salt was suggested as a bursting charge for shells nearly fifty years ago, whilst Sprengel showed that picric acid itself could be detonated, and later Turpin employed the acid as an explosive. It was found possible to get a great weight of explosive into a small space, as the acid could be melted and poured into the shell in a molten condition. Picric acid *per se* is a very safe explosive, but has the drawback of acting on metals to form picrates, some of which are far more sensitive to disturbing influences than the acid itself.

Experiences with lyddite shells in the South African war showed their behaviour to be very erratic, some exploding with great effect, whilst others gave disappointing results, this being due to the fact that picric acid requires a powerful detonator for obtaining the highest explosive effect, and the use of such a detonator was dangerous, and might cause a premature explosion of the shell within the gun.

The disadvantages inherent in the use of picric acid led to attempts being made to replace it by some other material of the same character, which could be used as a high explosive in a bursting charge and yet be free from these drawbacks. Such a body was found in trinitrotoluol, and although its explosive force is slightly less than that of picric acid, the pressure of the latter being 135,820 lb. on the square inch, as against 119,000 for trinitrotoluol, yet its advantages more than compensate for this difference. Not being of an acid nature, trinitrotoluol, or T.N.T., as it is termed, cannot accidentally form more sensitive salts; it is without action on metals, and is perfectly stable.

The formation of volumes of black smoke on detonation of the T.N.T. has given rise to the names given to shells containing this explosive of "Black Marias," "coal-boxes," and "Jack Johnsons," and the fact that this cloud of carbonaceous matter is produced shows conclusively that the oxygen contained in the nitryl radical present in the explosive is insufficient for its complete combustion. An excellent explosive used during the Balkan war, and now largely employed by the Austrians, is known as ammonal, in which 12 to 15 per cent. of T.N.T. is mixed with an oxidising compound, ammonium nitrate, a little aluminium powder, and a trace of charcoal. This mixture gives even better results than the T.N.T. alone, and its only drawback is the hygroscopic character of the ammonium nitrate, which necessitates the material being made up in air-tight cartridges. It forms, however, a most effective bursting charge, and although the rate of detonation of the trinitrotoluol is reduced by the admixture of the oxidising compounds, the shattering effect is even more destructive than when the explosive is used alone, as the pieces of shell scattered are larger in size. An improved form of this explosive is being made on a large scale in England for use by the Allies, and renders the supply of high explosives for shells perfectly adequate.

Toluene is obtained from the crude benzol in coal tar and by scrubbing coal gas, by fractional distillation, and is also being produced synthetically from other hydrocarbons by the action of heat and pressure, so it is safe to say that any requirements for toluene to nitrate can be amply met.

Under the influence of nitration other constituents of tar are converted into effective explosives, dinitrobenzol being the basis of such mining explosives as "Roburite" and "Bellite," whilst trinitrocresol has been used largely in place of picric acid, under the name of "Ecrasite," but it shares with picric acid the drawbacks of forming more sensitive compounds with bases and of having an acid reaction.

Expert opinion has by no means settled which is really the best of the high explosives, and although it was the Germans who were chiefly responsible for bringing T.N.T. into such prominence, there are not wanting signs that they are largely reverting to picric acid.

Probably the most powerful explosive known is made from benzene by converting it into anilin, and by nitration making this into tetranitro-anilin, an explosive of which a great deal more will be heard, whilst another derivative tetranitromethylanilin, known as "tetryl," is being used largely for primers and detonators.

III.—Poison Gas and Incendiary Bombs.

There are many gases known which are irrespirable. Some, like carbon dioxide, nitrogen, and hydrogen, act merely in the same way as water would do by cutting off the oxygen supply, which is a necessity to life, from the lungs, but have no toxic action on the system. Other gases, like carbon monoxide and cyanogen, are powerful poisons, less than 1 per cent. of which in the air will cause death by purely toxic action. Others again, like sulphur dioxide, chlorine, and bromine, may act by producing spasms of the glottis, and subsequent asphyxiation.

The use of asphyxiating gas is by no means the simple problem that one might imagine. In the first place, gases differ from other forms of matter in that the molecules of which they consist being free from cohesion, are able to intermingle, no matter how different may be their weights, a process which is known as "diffusion," so that unless the gas is very considerably heavier than air it intermingles with the atmosphere so quickly as to prevent its spreading in a poisonous quantity over any considerable area. No gas which is not more than double the weight of air could be used effectively in sufficient quantity to be poisonous at the distances likely to exist between the trenches. It is this that accounts for the fact that although 1 per cent. of carbon monoxide is instantly fatal, no deaths can be traced to its effects during the war, although all our propellants and high explosives give on explosion large volumes.

The weight of a gas is represented by its density, that is, how many times it is heavier than hydrogen, the lightest gas known, and in the following table are shown the densities of the various gases suspected of having been used or possible to use, and the relation of their weight to an equal volume of air:—

	Density	Times heavier than air
Sulphur dioxide ...	... 32	... 2·21
Nitrogen tetroxide	... 46	... 3·17
Chlorine	... 35·5	... 2·45
Bromine vapour ...	... 80	... 5·53
Phosgene	... 50·6	... 3·49

By the laws of diffusion gases intermingle at a rate which is inversely proportional to the square roots of their densities, but air currents or wind enormously increase the rate of admixture, so that with anything like a breeze blowing it would be impossible to use them successfully, whilst the opportunity for "frightfulness" is, of course, limited by the direction of the wind, so that in Flanders it is only with the wind in the north or a point or two on either side that effective use could be made of them.

During the past few months the prevailing winds have been in the enemy's favour for considerably more than the normal period, and it is to be hoped that during the next few months with the prevalent wind from the south or south-west the opportunity of using these gases will be reduced to a minimum.

The inhalation of a very small proportion of sulphur dioxide gas causes coughing, four volumes in 10,000 of air rendering it irrespirable, but if the sufferer escapes from the zone within a reasonable period the effects pass off, and the inhalation of dilute ammoniacal fumes rapidly affords relief. The gas can be easily liquefied by cold or pressure, and one pound of the liquid gives roughly 5 cub. ft. of the gas. The liquid sulphur dioxide is being used by the enemy in hand-grenades, which, broken by a small bursting charge, scatter the contents when thrown into the opposition trench, when they immediately volatilise, and often contain other volatile irritant bodies besides the sulphur dioxide.

Chlorine, which in all probability is the gas which has been used to the greatest extent, is of a yellowish-green colour. It can be liquefied under a pressure of six atmospheres, and has an insupportable odour. When inhaled even in minute quantities it causes great irritation of the mucous lining of the throat and lungs, air containing from 2 per cent. of it rapidly proving fatal. This gas can be made with the greatest ease by heating a mixture of hydrochloric acid and black oxide of manganese, but it is now produced in large quantities in certain electrolytic processes, from which it can be collected and liquefied, the liquid being stored in lead-lined steel cylinders closed by a valve.

In such a cylinder the gas above the liquid exercises a pressure of at least 90 lbs. on the square inch, so that if a cylinder containing it be fitted with a tube which passes down into the liquid and is provided at its exit from the cylinder with a valve, on opening the valve the liquid is blown out in the form of a spray, which at atmospheric pressure instantly assumes the gaseous form, and it is in this way that it has been chiefly used. It is reported, however, that where the German trenches are of a more or less permanent character, broad tubes with valves at intervals are laid a few feet in front of the trenches with the openings pointed towards the Allies, the trunk tubes being connected with a gasholder and chlorine plant situated in a sheltered spot some little distance away, so that the mere opening of the valves sets free a flood of gas without the disturbing influence of the cooling effect produced when gas is liberated from a cylinder of compressed liquid. The yellow colour of the gas employed has been a marked feature of all the more serious gas attacks, but it must be remembered that either chlorine or nitrogen tetroxide would give very much this effect, although the latter would be browner in colour.

Nitrogen tetroxide constitutes the fumes formed during the action of nitric acid on various substances in contact with air, and can be liquefied at temperatures below 26° C. to a liquid varying in colour with the temperature. Most observers from the front insist that this gas has been largely used, but this seems doubtful, as nitric acid and the oxides of nitrogen play so important a part in the manufacture of explosives that in spite of the large quantities of nitric acid made by electrical processes from atmospheric nitrogen, the enemy cannot spare much for this purpose, more especially as chlorine is more effective and wickedly cruel in its action, and can be obtained in any desired quantity without affecting the supply of any other munitions of war.

Only two liquid elements are known, mercury and bromine, and the latter, which is closely allied to chlorine in all its properties, becomes a vapour at atmospheric temperatures, and boils at 59° C. Germany produces practically the whole European supply from traces of magnesium bromide found in the great salt mines at Stassfurt. It is a reddish-brown liquid, and gives a vapour of the same colour, which violently attacks the eyes as well as the mucous lining of the nose, throat, and lungs. Its effect upon the system is the same as that of chlorine, and it is supposed to have been used by the Germans in asphyxiating shells, the bursting of which would scatter the liquid bromine and facilitate its conversion into vapour, which owing to its great weight would sink to the ground.

A form of poisoning used by the enemy has been the use of amorphous phosphorus in the shrapnel shells used partly for the marking of ranges. Amorphous phosphorus is a violet-brown powder, largely used in the composition on safety-match boxes, and differs widely from yellow phosphorus in that it is non-poisonous, and inflammable only at a temperature that converts it into the inflammable yellow form. A small cartridge of this included in the 18-pounder shell is converted by the heat of explosion into the ordinary variety, which burns, giving a dense white fume of phosphorus pentoxide, which marks the position of the bursting shell by day, and has conferred upon this type of shell the name of "woolly bear," and a flame which performs the same function of marking the position by night. When, however, a fragment of such a shell inflicts a wound the phosphorus poisons it, and very serious complications ensue.

Probably the phase of "frightfulness" that interests the British public as much as any is the bombs dropped by aeroplanes and Zeppelins, of which several distinct varieties are in use.

Besides these, incendiary bombs are used, which differ somewhat from those used by the enemy, and which for manifest reasons cannot be discussed. The incendiary bombs used by the Germans consist of an outer skin wound round with tarred rope, and containing a charge composed of a mixture of very finely divided aluminium and oxide of iron, which when ignited develops an enormous amount of heat owing to the combination of the oxygen of the oxide of iron with the aluminium.

This mixture is known in trade as "thermit," and was successfully introduced for practical use by Goldschmidt in 1898; it is now largely used for welding rails and other iron and steel structures, and also for repairing castings, indeed, for any purpose for which intense local heating is desired. In many of these bombs there is a layer of amorphous phosphorus at the base, which converted into phosphorus vapour by the heat of the thermit reaction burns with a rush of poisonous flame, igniting everything around, giving burns which, if not fatal, are poisoned and most difficult to get to heal, and also producing a cloud of fumes of phosphorus pentoxide.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LIVERPOOL.—Prof. R. Robinson, of the University of Sydney, has been appointed to the newly constituted chair of organic chemistry. The University has recently received the sum of 10,000*l*. from Mr. Heath Harrison for the endowment of the chair. Prof. Robinson, who will fill the chair, was a student of the University of Manchester, where in 1909 he was appointed assistant lecturer. He is well known for his investigations in conjunction with Prof. W. H. Perkin on the constitution of brazilin and hæmatoxylin, the synthesis of narcotine, and the constitution of strychnine, brucine, harmine, harmaline, etc. He was appointed to the chair of organic chemistry at Sydney in 1912.

PROF. J. MASCART, director of the Lyons Observatory, informs us that the city of Lyons has commenced the formation of a War Library, to contain a collection of works and documents on the events of 1914–15.

The Mayor of Lyons hopes to secure as complete a collection as possible of papers relating to the war, so that students and investigators of diverse subjects—meteorologist or historian, hygienist or sociologist—will eventually regard it as the central bureau for their own particular studies of the times through which which we are now passing. All branches of human activity having relation to war questions or problems will be embraced by the library, and no article or other publication will be considered too unimportant for inclusion. It is hoped that authors of all contributions upon these subjects will send copies of their works to the Bibliothèque de la Guerre of the city of Lyons, and will co-operate in other ways to make the collection complete.

UNTIL recent years the personal side of academic scientific history has not attracted with us the general attention that its human interest deserves. A notable exception is, however, afforded by the accounts given in the biographies of Lord Kelvin of the relations between Glasgow and Cambridge in his early days. A very interesting narrative of about ten years later has now appeared in the form of a notice of G. M. Slessor, of Queens' College, senior wrangler of 1858, and for a few years professor at Belfast, a mathematician of well-known achievement, whose high promise was cut off by early death at the age of twenty-eight. The biography, accompanied by a striking portrait, is in the *Aberdeen University Review* for June, 1915; it is written by the Master of Emmanuel, Dr. P. Giles, largely from material contributed by Sir James Stirling, F.R.S., who was a pupil and friend of Slessor, and was himself an Aberdonian senior wrangler a few years later. It may be commended to the notice of all concerned with the preservation of the scientific and academic personal records of the period.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 19.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The existence in our physico-mathematical sciences of fundamental chapters still in the same rudimentary state as the dynamics of Aristotle.—Georges **Lemoine**: The catalysis of hydrogen peroxide in homogeneous media with acids and alkalis. Pure water acts as a catalyser on hydrogen peroxide. The addition of acids even in very small proportions, some ten-thousandths, reduces the rate of decomposition. Curves are given showing the relation between rate of decomposition and concentration of acid for sulphuric and hydrochloric acids. Alkalis accelerate the rate of decomposition, and the results of experiments with soda, potash, and lithia are given.—C. E. **Guye** and Ch. **Lavanchy**: The experimental verification of the Lorentz-Einstein formula by kathode rays of high velocity. Using the method of identical trajectories described in an earlier paper it was found that the Lorentz-Einstein formula on the variation of the inertia as a function of the velocity was verified with great precision by all the measurements.—E. **Fleurent**: Remarks on bread for prisoners of war. A method of preparing bread is described giving a product not liable to mould, and preserving its flavour intact even after keeping a month or longer in a moist, dark cupboard.—Louis **Roule**: Fish from the lower depths of the sea of the family of Brotulideæ in the North Atlantic.—E. **Vasticar**: The nuclear formation of the external auditive cells and of Deiters cells.

BOOKS RECEIVED.

Chemistry of Familiar Things. By S. S. Sadtler. Pp. xiii+320. (Philadelphia and London: J. B. Lippincott Co.) 7s. 6d. net.

A Text-Book on Practical Mathematics for Advanced Technical Students. By H. L. Mann. Pp. xii+487. (London: Longmans and Co.) 7s. 6d. net.

Metropolitan Water Board. Eleventh Report on Research Work, together with Index to Research Reports. Nos. i.–x., inclusive. By Dr. A. C. Houston Pp. 52+vii. (London.)

How Belgium is Fed. Pp. 28. (London: National Commission for Relief in Belgium.)

The National Physical Laboratory. Report for the Year 1914–15. Pp. 136. (Teddington.)

The National Physical Laboratory. Collected Researches. Vol. xii., 1915. Pp. iv+173+plates. (London: Harrison and Sons.) 12s.

An Introduction to Mining Science. By J. B. Coppock and G. A. Lodge. Pp. ix+230. (London: Longmans and Co.) 2s. net.

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THURSDAY, AUGUST 5, 1915.

A CHAPTER OF BRITISH SCIENCE.

Electricity in Gases. By Prof. J. S. Townsend. Pp. xv+496. (Oxford: Clarendon Press, 1915.) Price 14*s.* net.

THE present book was written to appear as the first of six volumes of a handbook on Radiology, to be published in German under the editorship of Prof. Erich Marx. The translation of Rutherford's "Radio-active Substances and their Radiations" appeared nearly two years ago as the second volume of the series. The other volumes in preparation deal with kathode rays, X-rays, photoelectric effects, and the theory of electrons and X-rays. It was intended that the last two subjects should be treated by a number of well-known physicists, including Profs. H. A. Lorentz, P. Zeemann, Langevin, Einstein, Riecke and Sommerfeld. No doubt the publication of the later volumes has been delayed by the outbreak of war.

The best-known work on the passage of electricity through gases is Sir J. J. Thomson's treatise, of which a second edition was published in 1906. This gave a very complete account of the work up to that date in this new department of physics. Since that time the growth of experimental facts has been so rapid that it would be difficult to treat the whole subject adequately within the compass of a single volume. Fortunately a number of small books have been published from time to time dealing with special topics, *e.g.* H. A. Wilson's "The Electrical Properties of Flames and Incandescent Solids," Townsend's "Ionisation by Collision," Sir J. J. Thomson's "Positive Rays," Kaye's "X-Rays," W. H. and W. L. Bragg's "X-Rays and Crystals," Crowther's "Molecular Physics," and Soddy's "Chemistry of the Radio-Elements." These have proved of great value and interest in giving a first-hand account of recent advances of our knowledge in these special departments.

The present volume is mainly confined to a discussion of the properties of ions and the mode of conveyance of electricity through gases. The allied subjects of radio-activity, characteristic X-radiations, wave-lengths of X-rays, and thermionics, receive only passing mention, as they were to be treated in detail by other writers in subsequent volumes. After a preliminary discussion of the methods of production of ions in gases by different agencies, there follows a detailed discussion of the motion of ions in the electric field, the laws of their diffusion and recombination, and the methods of determining the ionic charge. The latter includes an interesting account of the experiments of Perrin. Then follows a very complete discussion of ionisation by collision—a subject which the author has made peculiarly his own. Other chapters are devoted to the discussion of the conditions and types of discharge between conductors of various shapes, and the passage of electricity through vacuum tubes. The final chapter gives an interesting review of the pioneer researches on the nature of the kathode and positive rays.

Our information on the subject of ionisation and the passage of electricity through gases has grown so rapidly, and is in many respects so definite and complete, that the reader is liable to forget how modern the subject is, for the whole advance is included within a period of less than twenty years. It is instructive to note what a prominent part British science has taken in its development. Practically all the pioneer discoveries in this subject were made in the Cavendish laboratory, and it is of interest to recall briefly the more important features in this advance. Shortly after the discovery that X-rays imparted a transient electrical conductivity to gases, in 1896 J. J. Thomson and Rutherford showed that the results were simply explained on the assumption that the current through the gas was due to the movement of charged ions produced throughout the volume of the gas by the radiation. This theory was soon generally accepted, and has formed the starting point of subsequent advances. Then followed the work of Rutherford on the recombination of the velocity of ions and the application of the ionisation theory to radio-activity. Zeleny discovered the difference in velocity between the positive and negative ion, and made the first accurate measurements of the mobilities. To this period belong the classical researches of C. T. R. Wilson on the ions as nuclei of condensation—investigations which have had such a remarkable development in recent years in making visible the processes occurring in the ionisation of gases by different types of radiation. Then followed the application of the ionisation theory to explain the conductivity of flame gases and flames by J. McClelland and H. A. Wilson, and later the investigations of H. A. Wilson and O. W. Richardson on the escape of negative electricity from glowing bodies.

We can only refer in passing to the pioneer experiments of Townsend, J. J. Thomson, and H. A. Wilson on the magnitude of the charge carried by the gaseous ions. In 1898 Townsend began his well-known researches on the diffusion of ions, and on the ionisation of gases by collision

—investigations which have had important consequences in many directions. Not only did the Cavendish Laboratory take a prominent part in the earlier discoveries, but many of the important later contributions in this subject have been made either by the students in that laboratory or by those who had come under its influence. In this review, however, we must not omit to mention the earlier contributions of Perrin and Sagnac, and the important theoretical and experimental investigations of Langevin, who for a time was an advanced student in the Cavendish laboratory.

The present volume is a very lucid and admirable exposition of our knowledge on this subject. The various theories which have been proposed and the experimental data are analysed with critical skill, and there are numerous original calculations added by the author himself. The mathematical theory of the subject is worked out with considerable detail, but is controlled at all points by careful consideration of the experimental data. The theory of the relation between current and voltage for ionised gases is mainly confined to the case of uniform ionisation, which, as is well known, presents many mathematical difficulties. No mention is made of the interesting cases that arise when the ionisation is non-uniform, or mainly confined to one electrode. Such cases often arise in experimental work, and it is important to direct the attention of the student to the marked differences in the current-voltage curves which are exhibited under different conditions of distribution of the ionisation. While the author does not profess to discuss the whole of the large number of papers that have been published in this field, a clear account is given of all the more important investigations, and great care has been taken in the numerous references to literature. It is probable that many of those who have followed closely the rise of this subject will not in all cases agree with the relative importance tacitly assigned to practically independent investigations in this field; but this, after all, is largely a matter of personal opinion. We can strongly recommend the present work as a sound and valuable contribution to our knowledge of the development of a very interesting and important branch of modern physics.

E. R.

THE PRINCIPLE OF RELATIVITY.

The Principle of Relativity. By E. Cunningham. Pp. xiv+221. (Cambridge: At the University Press, 1914.) Price 9*s*. net.

EVEN to the present day, the existence of the Principle of Relativity, which arose as a branch of physical theory, is somewhat troublesome to the individual physicist, owing to the efforts of his philosophical friends to obtain a precise account of its origin, treated from an historical point of view, which can emphasise the exact movement of thought leading to its adoption. The literature of the subject has been scattered in various periodicals, and so loaded with mathematical symbols that its appeal has been to a very limited audience, in spite of the real simplicity of all the ideas concerned. Three recent volumes will serve to remove this difficulty very effectually, and two of them possess the advantage of proceeding from entirely different points of view. The first, by Dr. Robb, has already been noticed in these columns, and the second is the volume by Mr. Cunningham now under review, which is designed to fill the gap specially indicated in our first sentence. The third, by Dr. Silberstein, already noticed also, is similar to Mr. Cunningham's, but is based on a different mathematical treatment.

Mr. Cunningham's intention throughout has been to consider those aspects of the Principle which have a direct bearing on the practical questions of physics, without more recourse to mathematics than is absolutely essential for a really valuable consideration of these questions, and it may be said at once that the simplicity of the treatment is remarkable. The matter is put in a very interesting way throughout, and even to the non-mathematician the volume is not difficult to read. The first part gives a very lucid outline of the manner in which the Principle grew out of electrical theory, and one feature which must be recorded with satisfaction is the accuracy of the account, which does not share a tendency, noted in the case of several writers, to bestow too much of the scientific credit for the Principle on those who have worked out the details, at the expense of the real originators, one of whom belongs to this country. The space devoted to any problem is strictly commensurate with its importance.

The author makes it clear in this section that there is a place for the Principle as a hypothesis supplementary to electrical theory, and on account of the necessary limits of that theory, independent of it. He avoids, at the same time, excursions into questions with metaphysical bearing.

In the second part of the work an excellent account of Minkowski's two representations is given. The four-dimensional world of Minkowski is by far the most interesting development of the Principle, and, unfortunately, hitherto the most inaccessible in this country. This section is undoubtedly the most valuable part of the book for the general reader, and although it is essentially mathematical, the author has minimised the difficulties as far as possible. Proofs of statements are printed in smaller type, and the general argument can be followed quite readily. Misconceptions of the position of the exponent of the Principle are frequent, and the exponent is not always free from blame. In these circumstances we welcome the explicit statement on p. 117—and the statement cannot be criticised—that while the Principle of Relativity cannot say what *are* the equations for bodies the motion of which is not uniform, it can say what they *may be*, and it therefore gives a powerful means of devising such equations to be tested by experiment. A similar definiteness is found in connection with the vexed problem of rotation.

The third part of the work is devoted to the necessary modifications of mechanical theory, on the supposition that the Principle is universal. Fundamental points only are dealt with, to the welcome exclusion of a mass of material the interest of which is almost entirely academic. Very speculative developments, such as that of Einstein in connection with gravitation, are omitted, and the author is thereby enabled to give a very clear view of the real implications of the Principle.

THE DEVELOPMENT OF MAN.

Heredity and Environment in the Development of Men. By Prof. E. G. Conklin. Pp. xiv + 533. (Princeton: University Press; London: Oxford University Press, 1915.) Price 8*s*. 6*d*. net.

ADDRESSING a general audience rather than a scientific gallery, Prof. Conklin deals in six lectures with the development of Man. In the first chapter he shows that development is the result of intrinsic factors, implied in the organisation of the germ-cells, and of extrinsic factors, the environmental conditions. The germ-cell is a living individuality, and development is one of its functions. New materials and qualities appear in increasing complexity, and this is due to active combinations and interactions under environmental influence. The hereditary germinal organisation is very complex, but development is no mere unfolding or unpacking. It includes processes of "creative synthesis."

The second chapter is devoted to the germ-cells and their organisation. "Development is progressive and co-ordinated differentiation of the germinal organisation, by which it is transformed into the adult organisation." Different kinds of substances are formed epigenetically; these are localised and isolated by intra-cellular movements and differential cytoplasmic divisions; and they are eventually transformed into various permanent structures.

The third chapter deals with the modes of inheritance, with special reference to Man. "Blending" is still retained on trial, but it is shown that "the principles of Mendel have served as an Ariadne thread to guide science through the maze of apparent contradictions and exceptions in which it was formerly lost." In the next chapter the author treats of the influence of the environment, and is more than usually careful in his analysis. He distinguishes the different kinds of developmental stimuli, the different times of their operation, and their varied results. There is a useful recognition of functional activity as a factor in development. "Nurture," it is argued, means much as a condition of individual development, but little as a transforming factor in evolution. For Man, however, with his social heritage, the evolution of the environment must corroborate eugenic improvements of the breed. In this and in the next chapter, which is devoted to a consideration of eugenics, the author turns repeatedly to the idea that environmental changes, saturating into the germ-cells, may incite heritable variations in the germinal organisation. The discussion of eugenics is restrained and wise. It is possible to improve the human breed (1) by preventing the seriously defective from reproducing; (2) by cultivating pride of race, and discouraging voluntary infertility on the part of those who have a goodly heritage; (3) by increasing opportunities for early and favourable marriages; and (4) by carefully conserving the best human mutations or heritable variations. But along with these eugenic endeavours there must go improvements of environment and training—including, pre-eminently, the development of control and good-will.

In the concluding pages Prof. Conklin explains how he, as a biologist, finds between the fatalistic and voluntaristic extremes a middle way which leads to action. We venture to commend the wise and stimulating discussion of the determinism involved in the creature's hereditary and nurtural relations and of the other side to this. The book is marked by sound judgment, firmness and clearness of treatment, and a vigorous buoyancy. It is to be strongly recommended to those who wish to understand the facts of human development in their relation to the larger problems of human life. The volume is well got up, effectively illustrated, and provided with a carefully selected bibliography and an unusually good glossary as well as a full index.

MATHEMATICAL CRYSTALLOGRAPHY.

An Amateur's Introduction to Crystallography (from Morphological Observations). By Sir W. P. Beale, Bart. Pp. vii+220. (London: Longmans, Green and Co., 1915.) Price 4*s*. 6*d*. net.

THIS exposition of crystallography has been written by "an amateur" with the intention to help "other amateurs." Amateurs differ, however, very widely in the variety and extent of their interests and also in their keenness. The author has evidently had a mathematical training, and it is this aspect of the subject that specially appeals to him. Very few amateurs, such as those possessing a collection of minerals, would, we imagine, be anxious to begin by calculating the axial ratios of their crystals. They would rather wish to gain some insight into the general relations of the external forms and symmetry of crystals; and they would be repelled by pages of mathematical discussion and formulæ. Having produced such a work on crystallography, the author must no longer regard himself as a mere amateur, but as a serious crystallographer. For these reasons the book cannot be recommended to amateurs; it should, in fact, be carefully kept out of the reach of anyone who displays the slightest curiosity respecting crystals, otherwise the spark will surely be extinguished. On the other hand, the book will be of real value to the serious student who has already made some start in crystallography, for it will present the subject to him in a somewhat different light from that given in the ordinary text-books; and taking the two together the subject will no doubt be studied more intelligently.

The author plunges into his theme by regarding a crystal as a geometrical polyhedron, and selecting three edges as axes of reference, he explains clearly how the positions of all the other surfaces of the solid are fixed in terms of the Millerian system of notation. Commencing with the most general (and difficult) case, namely that of the anorthic system, he leads the unfortunate reader through the maze of spherical triangles necessary for the calculation of the angles of inclination and the relative lengths of the axes of reference. The remaining systems of crystals are logically treated in turn, ending with the cubic. Here the important idea of symmetry is only incidentally touched upon. This is, however, treated rather more fully in the succeeding description of the merohedral forms belonging to each system. There is a long appendix on methods of calculation, and another on the drawing of crystals from the calculated elements.

The 136 illustrations (several of which are repeated for convenience of reference) are a special feature and are entirely original. These are well and clearly drawn, and the method of giving the axes of reference in red adds still more to their clearness. There is a slight slip in fig. 64, whilst fig. 65 is quite wrong. The book is clearly printed in large type, and there are but few misprints; {*hko*}, etc., instead of {*hk*o}, etc., however, recurs throughout the volume.

L. J. S.

OUR BOOKSHELF.

The Medical Annual. A Year Book of Treatment and Practitioner's Index. Thirty-third year, 1915. Pp. cxx+830. (Bristol: J. Wright and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1915.) Price 10*s*. net.

THIS, the thirty-third annual issue of this publication, contains a summary of the year's (1914) contributions to medicine and surgery by a number of competent authorities. The exceptional lateness of the isue is accounted for by the strain and distraction of a great war, all the contributors, fully occupied as they are in normal times, having been working under exceptional stress from military duties and contingent work. The list of contributors is a sufficient guarantee of the accuracy and up-to-dateness of the information given. Thus we find an account of the latest work on typhus and cerebro-spinal fevers, both of topical interest at the present time. Trypanosomiasis is dealt with by the competent hand of Sir Leonard Rogers, and the article gives full information of the latest work on the parasitology and treatment of this important condition. About twenty pages are devoted to the important subjects of radio-activity, X-rays, and electro-therapeutics, and useful sections deal with the changes in the new British Pharmacopœia of 1914. Special articles on naval and military surgery are included, together with references to personal experience in the treatment of wounds. A number of full-page and other illustrations are included, and form a special feature of the volume; they illustrate various disease conditions, details of surgical technique, surgical appliances, pathological features, etc. The two plates of skin eruptions in pellagra are beautiful examples of colour photography. The "Medical Annual" is a book eminently suited to the needs of the busy practitioner who desires to keep abreast with modern progress.

Wisconsin Geological and Natural History Survey. Bulletin No. xxxiv. Economic Series, No. 16. Limestone Road Materials of Wisconsin. By W. O. Hotchkiss and E. Steidtmann. Pp. viii+137. (Madison, Wis.: Published by the State, 1914.)

THIS bulletin has been published for the purpose of helping to conserve the expenditure of the "vast sums" now being spent upon the roads of Wisconsin. For the years 1907–1911 the appropriation by the State for highway purposes was 2000*l*. per annum, in 1912 it was 80,000*l*., in 1913 170,000*l*., in 1914 it had risen to 246,000*l*., and these figures represent less than one-third of the total amount spent on State-aided roads in the corresponding years. It must be remembered, however, that ten years ago there were practically no stone roads beyond the town boundaries.

The scheme of the report is excellent: part i. is a short introduction to the characters of the available road stones and to the methods of testing; part ii. deals with limestone, which appears to be the most convenient stone for use on the roads. The quarries in each county are described separately, and county maps show the distribution of the stone and quarries. Tests for each quarry were made by the Office of Public Roads (U.S. Department of Agriculture), part of the cost of which was borne by the State Highway Commission. The report of necessity possesses more local than general interest, yet it might well be taken as a model by the Geological Survey of Great Britain, which mentions quarries in a casual way in its memoirs, but has not yet produced one in which all the facts relating to a single important branch of the quarry industry are readily accessible.

Staffordshire. By W. B. Smith. Pp. xi+155. (Cambridge: At the University Press, 1915.) Price 1*s*. 6*d*. net.

In dealing with a county which includes two great manufacturing areas, an author might have been pardoned for giving an emphasis to the industrial character of Staffordshire, and for dwelling at length on the conditions which make Staffordshire the third county in industrial importance. Mr. Smith, however, has wisely balanced the more prosaic and unlovely areas against the beauty spots, such as Dovedale and the Moorlands, and the grimy factories against the fairer farms and the charming parks. The reader is introduced to dales comparatively unknown outside the county, to isolated items of interest such as the wild goats in Bagot's Park, and the Horn Dancers of Abbots Bromley. Those who have some acquaintance with Staffordshire will find much that is new in this book, which maintains the high standard of the series.

Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. v., SO—Z. Pp. 446. (London: Printed by Order of the Trustees of the British Museum, 1915.) Price 20*s*.

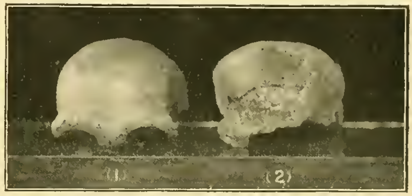
This volume of the catalogue of the collection of books, maps, and drawings in the Natural History branch of the British Museum brings the series of entries under the authors' names down to the end of the alphabet. The plan of the catalogue is that of the previous volumes, and was described when these were noticed in these columns.

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.*]

Palæolithic Man in South Africa.

In November of 1913 Mr. J. L. Groenewald, a farmer, of Adelaide, C.P., showed me some pieces of fossil bones, explaining that he had obtained them from a friend's farm at Boskop, in the Transvaal. He wanted my opinion as to whether they were human or not. I pronounced them to be portions of a human skull-cap of some very ancient race, and prevailed upon him to give them to me. A subsequent examination, after the parts had been fitted together and measured, made it clear that it was of a race as



Front view of the two skull-caps. (1) Neanderthal; (2) Boskop.

Back view of the two skull-caps. (1) Boskop; (2) Neanderthal.

Side view of the Boskop skull-cap, in comparison with the typical Neanderthal skull-cap. (1) Boskop skull-cap; (2) Neanderthal skull-cap. The forehead parts face outwards.

ancient, or more so, than the Neanderthal or the La Chapelle man. It bears a close resemblance in shape, thickness, and measurements to the former. The skull is as completely fossilised as the Karoo fossil reptiles. That it is of vast antiquity is certain.

This Boskop man differs from the typical Neanderthal type in having a lesser development of the frontal sinus, and a somewhat greater development of the forehead. This would indicate that the Boskop man was of the Neanderthal race, but more advanced in intelligence than the type specimen.

The discovery of this skull offers an explanation of the origin of the Palæolithic implements which are scattered in such vast profusion all over South Africa, and should it prove to be of the true Neanderthal race, as I have absolutely no doubt is the case, we then possess evidence that this remotely ancient type of man migrated into South Africa, and if we conclude the stone implements with which the country is strewn are his handiwork, then he must have existed here in large numbers.

Mr. Piet Botha, the owner of the farm on which the skull-cap was found, readily granted permission for me to excavate. I excavated the site of the find in person, and discovered portions of a rib and collar-bone, part of the mandible with a tooth in it; some more fragments of the skull, and a few roughly chipped stone implements. The remains were found at a depth of 6 ft. in alluvial gravel. On application, the South African Royal Society subsequently made a grant to this museum of 100*l*. to carry on further excavations. The result was disappointing, a small portion of a human thigh-bone being the only result of this more extensive excavation.

The skull-cap and other remains are now in the temporary possession of Dr Péringuéy, of the South African Museum, where a careful and detailed examination is being made, but which cannot be completed until various data and measurements are procured from Europe. The first report will appear in the Journal of the South African Royal Society.

F. W. FITZSIMONS.

Port Elizabeth Museum, Port Elizabeth,
June 30.

MR. FITZSIMONS's letter is the first authentic account published in Europe of the discovery of ancient human remains at Boskop Farm in the Transvaal. There can be no mistake about the importance of the discovery; the remains of Palæolithic man have at last been found in South Africa. As regards the nature or race of the individual thus found there is room for doubt; an examination of the photographs of the skull-cap reveal none of the characteristic features of Neanderthal man; one can exclude that race with some degree of certainty. The individual to whom the skull-cap belonged was apparently of the modern type, with a head of remarkably large dimensions. European and American anthropologists look forward with great interest to the publication of a detailed account of the Boskop discovery.

ARTHUR KEITH.

Surface Tension and Ferment Action.

THE correspondence in NATURE of June 17 and July 22 by Dr. Cramer and Drs. E. F. and H. E. Armstrong on the possibility of the enzymic action of invertase being limited by surface tension, has led me to look up the laboratory records of some experiments which I made in 1892 on a cognate subject. I was at that time engaged in studying the formation of starch granules in various parts of the living plant, and the subsequent dissolution of the granules under the action of the cell enzymes.

In the course of this inquiry I came across a curious fact which suggested that the action of the diastatic enzyme is to some extent dependent on physical conditions existing at the limiting surface of the starch granule and its surrounding medium. Briefly stated, this fact is as follows.

If we mix with a dilute cold-water extract of malt a little solid starch of a kind which is readily attacked by diastase, *e.g.* that from buckwheat or barley, a microscopic examination will generally indicate a very appreciable erosion and partial disintegration of the granules within twenty-four hours, the actual time depending on the initial concentration of the enzyme. If a parallel experiment is so arranged that, with all other conditions remaining the same, the starch granules are kept in suspension by the addition of about 3 per cent. of gelatine, then we invariably find that the rate of erosion and dissolution of the starch is very much accelerated. This difference is also found to occur even if the mobile liquid which contains no gelatine is kept in continuous movement by mechanical means.

It appeared to me that very possibly the lowering of the surface tension of the liquid by the gelatine had enabled the large-moleculed diastatic enzyme to penetrate the granule with greater facility, and since the starch granules in plant-cells are suspended in highly colloidal protoplasm we might here have some sort of explanation of their rapid disappearance under the influence of very small amounts of active enzyme.

Reasoning from these facts, I drew the conclusion that in a given mixture of starch and enzyme we ought to find a diminution in the rate of erosion in those parts of the liquid which are in a state of tensile stress.

My first experiments in this direction were made in a flattened thermometer tube with an elliptical bore having a major axis of 0·4 mm. and a minor axis of 0·2 mm. The bore of the tube was charged with the diastatic liquid containing the starch-grains, which could be kept under microscopical observation through the walls of the tube. Under these conditions, the starch granules invariably showed a much higher resistance to erosion than did those of the same liquid contained in a small flask or beaker under similar conditions of temperature. At first sight this experiment gave some support to the idea of surface tension playing a part, but in a variation of it in which I used a thin film of the starch mixture between two inclined glass plates, I could find no difference in the rate of erosion in layers varying in thickness from 0·3 mm. downwards.

I then proceeded to investigate the action when the starch had been deposited in the interstices of porous substances, and in the first place used glass-wool, which was one of the substances employed by Messrs. Beard and Cramer, as described in their recent paper in the Proceedings of the Royal Society (vol. lxxxviii., ser. B, p. 575), on surface tension and ferment action. Under these conditions the erosion even of buckwheat starch, which is the most sensitive to action of this kind, *was entirely inhibited*, no matter how long the reaction was allowed to continue. For a short time I was misled by this result, and it was only after I had recognised the distinct alkalinity of the solutions which had been in contact with the glass-wool that I found the *causa causans* was of a chemical and not of a physical nature. Diastase, like invertase, is extremely sensitive to traces of alkali, and can only exercise its maximum effect in a slightly acid medium.

I satisfied myself that this was the true explanation by substituting for the glass-wool in the last experiment other porous substances, such as asbestos, cotton-wool, and filter paper, when the whole of the inhibitive effect disappeared. Thus failed my attempt to link enzymic action with surface tension, and even the original phenomenon with which I started, the apparent enhancing effect of a colloid like gelatine, admits of a different explanation based on the slightly acid reaction of the commercial product. It is now well known that an amylohydrolytic agent, such as a malt-extract, is increased in activity by the addition of traces of acid sufficient to convert the neutral into the acid phosphates.

I believe that most scientific workers have, like myself, a scrap-heap of failures which may repay a little digging now and then. In the light of the recent discussion in your columns these few potsherds which have been recovered from the overlying débris of years may at the present moment have something more than a mere antiquarian interest.

Horace T. Brown.

52 Nevern Square, Kensington, S.W., July 24.

The Cancer Problem and Radio-activity.

Prof. Joly, in an address published in Nature of June 10, has given some more facts in connection with the theory associating radio-activity with the cause of cancer; and his endeavour to extend the theory so as to connect some of the commodities which predispose the tissues to the disease will be read with interest by those engaged in cancer research. But there are other such commodities which Prof. Joly has not apparently taken into consideration, especially arsenic and manure; and he is not correct when the attributes "sweep's cancer" to mechanical irritation.

The last point was demonstrated at the recent Home Office inquiries on pitch ulceration and cancer, in association with which extensive research has been made at the John Howard McFadden Laboratories. It appears that there are two forms of pitch, the blast-furnace variety produced at a lower temperature mostly from Scottish coal, and the ordinary gas-tar variety made from bituminous coal. Both varieties are similar in consistency, and both cause similar mechanical injury; yet blast-furnace pitch is harmless, whereas gas-tar pitch gives rise to a considerable incidence of warts and sweep's cancer. Coal-dust may cause mechanical injury amounting to laceration; yet it causes no cancer. Soot, being soft and floury, does not mechanically irritate the skin, yet it occasions in sweeps more cases of cancer than in any other trade. Tar and some of the petroleum fractions are liquids, and cannot cause mechanical injury; yet they both are sources of skin epithelioma.

These commodities evidently give rise to the disease owing to the presence of some chemical agent contained in them, for the more they are concentrated the more disease do they cause. Coal causes no cancer; tar, the residue after the first stage of its distillation, causes some cases; pitch, the residue of the distillation of tar, causes such an incidence as to necessitate two official inquiries; and soot, the last residue of the carbonisation of coal, tar, and pitch, causes the most cancer among occupied males. The question is what is the substance that is being concentrated, and how does it act?

The researches which have been made on this subject are based on the fact that many classes of cells can be made to divide in response to auxetics—chemical agents which contain the amidine or amino groupings. This has been shown now with many classes of cells, including human cells; and Cropper and Drew have recently found that amœbæ, when isolated from other living organisms and placed in pure water, will not divide at all without the addition of an auxetic. Auxetics are physiologically set free in a tissue as the result of cell-death caused by injury; and when they are inoculated into certain tissues can be made to give rise to benign tumour formation, both in men and animals. There is another group of substances (including most of the alkaloids, choline, cadaverine, etc., to some of which Prof. Joly refers) that increase the action of auxetics very considerably. They have been called augmentors.

Since auxetics cause benign cell-proliferation—which is a very favourable condition for the onset of cancer, a large number of the coal-tar commodities and fractions were tested for auxetics by trying watery extracts of them on human cells. The commodities were sent to the laboratory by the authorities distinguished by numerals only; some were known to cause cancer, others were known not to do so; but the workers who made the tests were unaware as to which were which until the tests were complete. In this way it was ascertained that, by the simple test for auxetic or augmentor, those commodities (about 20) which give rise to cancer can be picked out from a large number (about 150) of those which do not.

Hence it is more than probable that the commodities act by virtue of the auxetics or augmentors they contain; the successive fractional distillations of coal, concentrating the auxetic in each stage, causes a higher and higher incidence of cancer, until the ultimate production of soot with the highest incidence of all (chimney-sweep's cancer).

Since then, all the other commodities which cause cancer, such as arsenic, manure, betel nut (a putrid mixture of areca and tobacco), tobacco and its smoke, "khangri" charcoal, some aniline dyes, and petroleum, have been tested, and all contain auxetic or augmentor. On the other hand, the harmless blast-furnace tar and pitch and the hard Scottish coal whence they are derived contain either no auxetic or augmentor or only a trace of the former.

X-rays and radium rays in certain dosage will produce cancer; but they also cause cell-death, even amounting to ulceration, which in its turn sets free auxetics resulting in cell-proliferation, which is prone to become malignant. Atrophy following nerve disease and injury again produces auxetic in a tissue, and these atrophic areas are liable to epithelioma, as admirably described by Lenthal Cheatle.

Much work remains to be done, therefore, before the theory regarding radio-activity can be proved to harmonise with all the facts, which must include an explanation of why it causes the death of the patient and metastasis. I do not wish to question its soundness; on the contrary, an experiment which Dr. Lazarus-Barlow has kindly made in comparing the radio-activity of the auxetic fractions of gas and blast-furnace tars appears to be evidence in its favour. Even if auxetics ultimately prove to be the sole immediate cause of cell-division, some physical force must produce the division activated by the chemical agent when it has arrived within the cell, and it is possible that this force is connected with radio-activity.

In conclusion it may be mentioned that the terms "industrial cancer," "smoker's cancer," "sweep's cancer," "arsenic cancer," etc., namely, the diseases caused by the commodities mentioned, refer in reality only to a predisposition to the disease. The commodities themselves do not actually cause cancer; they merely render the tissues prone to it, which seems to occur in a specific manner. This was clearly shown at the inquiries; the commodities always in the first instance produce cell-proliferation usually in the nature of warty growth; and it is not until an open ulcer has appeared, generally at the base of the wart, that malignancy supervenes. This fact, coupled with the knowledge that augmentors are produced in a proliferative site by the action of bacteria, makes one suspicious that the exciting cause of cancer is probably of bacterial, or, in any case, parasitic origin. The clinical evidence and the experiments that have been made into the causes of cell-proliferation and industrial cancer demonstrate that when we speak of the cause of cancer we are dealing with two factors—(1) a predisposing cause, probably due to auxetics, which are set free by injury, X-rays, and atrophy, which are actually injected into the tissues by the commodities, and which occur in excess in the tissues generally in persons above the age of forty—the cancer age; and (2) an exciting cause, the nature of which has still to be worked out, and which supervenes on top of (1). Whatever this exciting cause is, it is responsible for the metastasis and death. It would seem that a combination of the two causes is essential, namely, that cancer is due to local manuring of the tissue; either one or other by itself appears only to cause benign tumour formation. H. C. Ross.

The John Howard McFadden Research Fund,
The Lister Institute of Preventive Medicine,
Chelsea Gardens, S.W.

DR. Ross's letter raises the question as to whether photosensitive molecular systems of the nature of those contained in the gelatino-bromide emulsion might not be affected by auxetics and augmentors applied under suitable conditions. If such effect was found to exist, the facts he adduces would not be out of line with the view that some molecular change within the cell finds a counterpart in actions progressing in the unstable film under the stimulus of radiation or equivalent chemical influences.

The reasons set forth by Dr. Ross against the theory that soot acts mechanically appear convincing, although I cannot agree with him that this substance can be described as soft and floury. There has always been difficulty in accounting for its peculiar virulence on the mechanical theory. Some time ago I looked for the emanation of radium in soot, but found very little. If it acted like charcoal we would expect a large amount, in which case Dr. Lazarus-Barlow's views would find additional support in this direction.

I may add that some of the suggestions put forward in the lecture which was in part issued in NATURE of June 10 have been under investigation here for some time. J. JOLY.

Trinity College, Dublin.

The Magnetic Storm of June 17 and Solar Disturbances.

As my final note on Dr. Chree's letter in NATURE of July 22 and Mr. Buss's of July 29 may I remark that, so far as I am aware, there is no rule, "One spot, one storm"? On the contrary, a disturbed area of the sun's surface may be connected with a series of successive, or intermittent disturbances, as it is carried round by the sun's rotation. When the same region reappears at the next synodical rotation, and sometimes, if it survives as an active region, for several synodical rotations, it will continue to be associated with a series of magnetic disturbances at each rotation. For instance, in 1898, January 11 to July 31, a disturbed region of the sun, which subsisted during eight rotations, was associated with not one only, but with several magnetic storms, at each successive reappearance. Nor is the selection of such a region arbitrary, when there happen to be several other disturbances at the same time on the sun. The selection is conditioned by the activity of the region, and by its position relatively to the position of the earth, when projected on the sun. So far as I am aware, mere statistical enumerations of sun-spots, or total areas of sun-spots, and their relations to magnetic storms, take no account of these important considerations.

The efficiency of a disturbed region of the sun, marked by sun-spots, is greater on the descending portion of the sun-spot curve than even at maximum. The reason of this is, because after the maximum, the mean latitude of the spots is falling towards the sun's equator, and since the heliographic latitude of the earth varies between $\pm 7^{\circ}$, the earth is placed in a more favourable position to be affected by a solar disturbance. In the twenty-five years, 1889–1913, there were seven years in which the mean daily projected or disc-area of sun-spots was greater than $1000\ 10^{-6}$ units, and eighteen years in which it was less. In the seven maximum years there was a mean of 100 disturbances a year, and a yearly mean daily disc-area of 1537·7 units. The ratio between these two numbers, or what may be termed the "efficiency ratio," is 0·065. Similarly for the eighteen years in which the mean daily disc-area was less than $1000\ 10^{-6}$ units, the mean number of disturbances was 73·7 per year, and the yearly mean daily disc-area was 378·9 units, which gives an "efficiency ratio" 0·195, three times as great as in the maximum years. Of these eighteen years, twelve were on the descending arm of the sun-spot curve. These numbers show that the position of a disturbed region of the sun relatively to the earth is more important than its size. In addition, the character of the spot has to be considered.

To apply these principles of selection to the case of the magnetic storm of June 17. Since the beginning of 1913, all the sun-spot disturbances, with insignificant exceptions, had been confined to regions above 12° on each side of the solar equator. From June 12 to June 21 an entirely new active group of spots covering a considerable area appeared on the sun's equator. The heliographic latitude of the earth was also most favourable. The first very great magnetic storm of the present solar cycle took place on June 17, preceded by a disturbance on the 16th, and followed by a disturbance on the 18th.

With regard to the 27-day period shown in the quiet magnetic days, I associated them with the whole solar hemisphere only in this sense, that, as a rule, when there is no solar spot, there is no magnetic disturbance. The proviso is added, because a region of the sun which may be free from spots may, by the presence of faculæ or flocculi, still continue to be magnetically active, after the spots have died away. In several cases the region will continue to be magnetically active, on account of the appearance of new spots near the faculæ or flocculi belonging to the former disturbance. A. L. CORTIE.

Stonyhurst College Observatory, Blackburn,
Lancs., July 23.

Science and Food-Supply.

IN connection with the proposed "Mobilisation of Science," it may be of importance for Great Britain to direct the attention of her scientific men to the possibility of increasing the food-supply produced in the country. Here she might very hopefully call upon her organic chemists for aid; by asking them to devise means for extracting nutritive material from the crops which are not now used for food.

Nearly all vegetable matter contains the nutritive elements needed. In a certain sense, for example, "all flesh is grass"; but we cannot digest vegetable matter of that kind directly; it must be put through a chemical process before it can be assimilated. The process usually adopted is to put it into the stomachs of animals, and then we eat the animals. Through the intervention of cattle and sheep we thus eat grass in the form of beef and mutton.

In a similar manner, deer and goats and many other animals which are not limited to a grass diet convert moss, and shrubs, and bark, and small branches into nutritive material for man. The wood of trees, too, contains the necessary elements for the support of life; but we do not utilise wood for food, because we have no animals that feed upon wood. Could not chemists do something with wood-pulp in this connection?

The German chemists are reported in the American newspapers to have succeeded in treating sawdust so as to extract a nutritive product that can be digested by man, the so-called "bread from sawdust."[1] If this is true, the British chemists should certainly be able to arrive at a similar result.

How secure Great Britain would be if she, too, could make bread from sawdust, and convert grass and shrubs and other vegetable matter not now utilised into food for her people. Here is a problem of the greatest consequence to Great Britain that should be brought to the attention of her scientific men.

ALEXANDER GRAHAM BELL.

Beinn Bhreagh, near Baddeck, Nova Scotia,
July 10.

[1] For other references to what the German chemists are doing, see article on "Inorganic Fodder" in the *Scientific American* for July 3, p. 8; in which reference is also made to an attempt to derive from straw and hay all the nourishing matter contained therein.

THE PROMOTION OF RESEARCH BY THE STATE.

THE Government scheme for the organisation and development of scientific and industrial research, of which we gave particulars last week, represents a welcome concession of a principle always advocated in these columns, and stated with particular force by Sir Norman Lockyer in his presidential address on "The Influence of Brain-power on History," delivered at the Southport meeting of the British Association in 1903. The duty of a State to organise its forces as carefully for peace as for war was emphasised on that occasion; and it was urged that adequate provision for scientific education and research is an essential part of a modern State's machinery, and should be efficiently organised if we were not to fall behind other nations in the applications of science to industry. The recognition of the State's responsibility in this matter would have come much sooner if our statesmen had been wise enough to understand the scientific factors of industrial success; but it has at last been given, and the unanimous approval with which the scheme has been received must be a little surprising to the politicians who have taken so long to realise the part science is playing in the modern world, and to make provision for its national use.

There is nothing, perhaps, so difficult as to alter a long-established tradition, to effect a real change in the mental attitude of a person or of a nation. It is the greatest of revolutions; it is the real revolution on which all action out of harmony with the tradition of the past depends. Such a change of attitude, so far as the official mind of the country is concerned, was announced last May by Mr. Pease, then President of the Board of Education, when he stated in the House of Commons:

> The war has brought home to us . . . that we have been far too dependent . . . upon the foreigner, and we have realised that it is essential, if we are going to maintain our position in the world, to make better use of our scientifically trained workers, that we must increase the number of those workers, and that we must endeavour to secure that industry is closely associated with our scientific workers, and promote a proper system of encouragement of research workers, especially in our universities.

These convictions have been translated into deeds through the issue of the Government scheme. The action which has thus been taken by the Government will be hailed by all men of science with feelings of the utmost gratification. It is difficult to overestimate the value of the consequences which may follow—which, indeed, we feel sure will follow—from the adoption of this scheme. By its inception and publication the Government acknowledges and proclaims its appreciation of the work of science, and by this acknowledgment alone it gives scientific workers that encouragement and prestige in the eyes of the country which have too long been withheld.

The expenditure of any new moneys provided by Parliament for scientific and industrial research will be under the control of a committee of the Privy Council, upon the recommendation of the Advisory Council. The appointment of Lord Haldane as a non-official member of the committee of the Privy Council connects the British Science Guild with the work contemplated by the Government scheme. Lord Haldane was the first president of the guild; and at the inaugural meeting in 1905 he said:—

> I believe that things will not be right until we have a scientific corps under a permanent committee, just as the Defence Committee is under the Prime Minister to-day. I mean a body that will not consist mainly of officials of the ordinary kind, but of the most eminent men of science, who will be put on the footing upon which they deserve to be placed, and are recognised as a body of men who will be at the elbow of the department and can organise the scientific work of the State. I hope that if we get to this position the example of a Government adopting science will be followed by the municipalities, as I believe it is going to be followed more and more by our manufacturers.

The British Science Guild may justly claim some credit for securing the State assistance for industrial and scientific research now provided for by the Government scheme. For the ten years of its existence it has persistently pointed out that our competitors have brought all the products of science into the contest they have waged against us; and it has urged the adoption of similar methods in our national affairs and manufactures. Scientific men are so closely concerned with their own particular researches that they frequently take little interest in the work of others or in the position which science should occupy in national polity. Their inactivity in this respect is largely responsible for the neglect of science. A public movement was required to direct the attention of the public in general, and the Government and political parties in particular, to the value of the great resources of science in the development of the kingdom; and this movement took shape in the British Science Guild. The purpose of the guild is not so much the acquisition of new knowledge as the appreciation of its value, and the necessity of employing scientific methods in all departments of the national executive. We regard the Government scheme as a measure of acknowledgment of the principles of State responsibility and guidance advocated by the guild; and the only regret is that action on these lines was not taken long ago, as it would have been if we had been governed by far-seeing statesmen instead of party politicians. The consequences of Government recognition will certainly be that science will secure increased attention in the thought of the nation generally, and will receive more sympathetic consideration from the industrial world.

The country, as a whole, will be influenced by the lead of the Government. "It appears incontrovertible that if we are to advance or even maintain our industrial position, we must as a nation aim at such a development of scientific and industrial research as will place us in a position to expand and strengthen our industries and to compete successfully with the most highly organised of our rivals." The attitude of mind of the British people, as a nation, towards science, and public estimation and appreciation of its value, must undergo a profound change. It is for the purpose of effecting this change and directing the resulting activity that the Government has established a permanent organisation for the promotion of industrial and scientific research.

The main channels of activity of the organisation, of which the advisory council of seven experts is the most important part, will apparently lie in three directions. First, the advisory council will act as scientific advisers to all Government departments concerned with or interested in scientific research; secondly, the advisory council, with the co-operation of the various scientific societies, will consider the application of science to industry, and will seek to enlist the interest of manufacturers; thirdly, the advisory council will advise the Board of Education as to steps which should be taken for increasing the supply of workers competent to undertake scientific research.

With regard to relations between the manufacturers and the advisory council, it is sincerely to be hoped that the former will lend their utmost assistance to the scheme, which is devised largely in their interests.

On the educational side the work of the advisory council will be of the greatest importance. As has recently been emphasised by Dr. Beilby, "our colleges have two distinct functions to perform, and it is best that this should be clearly recognised, first to allow the future leaders in applied science to come naturally to the top during their training, and secondly, to prepare a large number of well-trained professional men for the organisation and development of industry." How best to secure these two classes of men in adequate numbers, and, more important perhaps, how to induce an adequate number of the right kind of men to enter the chemical profession, will require careful consideration on the part of the advisory council. It may, however, be hoped that the council will not pin its faith too much to bursaries and scholarships, but will rather seek to create inducements in the shape of posts which are adequately remunerated, more highly remunerated certainly than has been the case in the past.

MODERN PROCESSES OF MANUFACTURING HYDROGEN FOR AIRSHIPS.

IN the *Revue Générale des Sciences* for June 15, M. A. Fournois reviews the earlier methods for the preparation of hydrogen for balloons, and describes in some detail the more modern processes for its manufacture, especially those adapted to field use. The large amount required in the present campaigns can be conjectured from the capacity of the latest type of Zeppelin, which is stated to be some 30,000 cubic metres.

Many of the earlier processes now possess little beyond theoretical interest. The well-known zinc-sulphuric acid reaction always presented difficulties in the transport of materials, of which large amounts were required. The dangers attendant to the transport of the acid were largely overcome by absorption with acid sodium sulphate, the solid material being dissolved as required, but some 15 kilos. of the mixture were necessary for the preparation of one cubic metre of the gas.

The electrolytic production was a great advance, although the process was naturally expensive, and only possible at fixed generating stations. When the preparation of chlorine by the electrolysis of salt solutions was developed, hydrogen, being a by-product, was available at a cheaper rate. Such gas must always be supplied compressed in the usual gas cylinders, and here again transport difficulties arose, to say nothing of the dangers inherent to the transport of gas at 150 kilos. pressure into the field. One of the ordinary waggons will carry only some 13 kilos. of hydrogen—a small proportion of the total weight of the load—and this is roughly only one-hundredth of the gas required for an ordinary dirigible.

Naturally therefore great attention has been directed during the last few years to methods of preparation suitable for field use. The most successful of these have been the action of water on calcium hydride (CaH_2) (hydrolite), and the action of caustic soda on ferrosilicon or silicon itself.

Hydrolite is an expensive material—about five francs per kilo.—but the total cost of the outfit for 50,000 cubic metres is given as only about one-third of the cost of the gas in cylinders, one vehicle sufficing for the transport of the hydrolite plant, as against twelve required for gas cylinders. A vehicle carrying six generators gives an output of 500 cubic metres per hour.

In the ferrosilicon process the fine material falls into caustic soda, which is covered with a layer of hydrocarbon oil to prevent frothing. A base plant has an output of 1500 cubic metres per hour; a field plant, comprising two waggons, 400 cubic metres.

Hydrogenite—a mixture of ferrosilicon with dry caustic soda, which only requires addition of water for generation of the gas—has been used in the French service. One cubic metre of the gas is produced from 3 kilos. of the hydrogenite. The German Schuckert process employs silicon alone, an expensive material, and one which requires external heating of the generators.

Two other most interesting processes for the preparation of gas for balloons are mentioned. The decomposition of acetylene in strong steel cylinders by electric sparks is of particular interest by reason of the gas prepared in this way having been used at the Zeppelin factory at Friedrichshaven. The process gave rise to a serious explosion in 1910. The finely divided carbon deposited in the decomposition cylinders is used for the manufacture of printers' ink.

Another process, of Dutch origin, that of Rincker and Wolter, has also been used in Germany. Generators filled with metallurgical coke are blown to incandescence, the air blast shut off, and suitable oils injected until the fall of temperature necessitates a further air blast. In a portable plant described in a recent issue of the *Scientific American*, one waggon carries two generators, with oil tanks, blower, &c.; a second car carries the purifiers. The gas passes through the generators in series, and purification is effected by sulphuric acid scrubbing, and finally by caustic soda to remove carbon dioxide. With highly incandescent coke the gas is stated to be nearly as light as hydrogen; it has some illuminating value, and is also stated to be suitable for use as an auxiliary gas for furnace work.

SCIENCE, MUSEUMS, AND THE PRESS.

TECHNICAL workers in science and in allied fields are accustomed to say that the general Press either pays no attention at all to subjects which they themselves believe to have a very important bearing upon the welfare of the people, and to be if properly treated of great public interest, or that it seizes upon only some isolated facts which are capable of being treated in a sensational way so as to furnish "good copy," but with the result of conveying an erroneous and often harmful impression. It is, we are constantly assured, the fact that newspaper editors really would like to have good and accurate popular articles on various branches of science, both pure and applied. The difficulty in obtaining them is twofold. First, that the ordinary journalist, untrained in special subjects, cannot be expected to see the really essential points or to present them in an accurate manner. Secondly, that the scientific worker generally has far too heavy a touch to appeal to the public. An attempt is sometimes made to bring the journalist and the man of science into co-operation by means of an interview, but in this country, at any rate, the scientific worker is apt to dread personal advertisement, and on the other hand he may not altogether care about giving news or opinions of pecuniary value for another person to take the reward. At any rate the interview generally results in the man of science being made to utter some notable absurdities.

There is, however, another intermediary through which the technical worker can approach a wider public, and that is afforded by the public galleries of our museums, which are coming more and more to rank as educational establishments of prime importance, catering not only for advanced students, but also for school children, and for many who might object to any title so serious as that of students. In so far as the exhibited series of our museums are intended to appeal to this wider and less educated public, they must do so by means of striking objects, attractive installations, and specially prepared labels. To these may be added: printed guides, which are purchased by a very small percentage of the visitors, and in any case are not as a rule written in a style alluring to those who seek amusement rather than instruction; human guides, who may take a perhaps larger but still a small percentage of the visitors round the galleries; and lastly, lectures with the added attraction of lantern-slides, dealing with special portions of the collections.

Many museums, both in Europe and America, are working hard along these lines, and have effected a considerable increase in the number of their visitors. But when all is said and done the proportion of visitors to the number of the surrounding population is indeed a small one. Some American museums claim a proportion as high as 35 per cent., but this, it must be remembered, refers to the number of visits, not to the number of visitors, which is certainly considerably less. Now it is absurd to spend money, time, and trouble in producing an attractive exhibition and then to leave members of the public to find out the fact for themselves. The museums must not be above taking the same steps as are taken by all other caterers for public amusement and instruction. In some form or other the museum must advertise. Here, then, may possibly be found a solution of the difficulty with which we started. Let the museum frankly admit that it must advertise, and let it take the Press for what it is, as the best advertising agent. The Press, on the other hand, welcomes good copy, and in return for that will not in the least mind directing attention to a public non-commercial institution. To accomplish this, the museum should have under the control of the director, a Press department, composed of the best writers on the staff, each of whom should be instructed as part of his official duties to draw up striking articles, not falsely sensational, but none the less abounding in "crispness," "snap," and "go."

Some such course as that just advocated is now being taken by the Smithsonian Institution, which for the past year or two has distributed to the general and scientific Press free articles written in lucid, popular fashion, dealing with all kinds of matters of novel interest in the United States' National Museum, and with other branches of the

Institution's work. Among the subjects of those which have lately been sent to us may be mentioned: "Orchids," "Stegosaurus," "Whetstones," "American History," "Fashions," "Gerenuk Gazelle," "Printing for the Blind," "Relics of the Grinnell Expedition," "Spectroscopic Determination of Minerals," "Gypsum," and "Printing Ink." Some of these deal with publications, others with accessions to the collection or with special exhibitions. Newspaper editors are at liberty to make what use they please of these articles, condensing or embroidering at their fancy. But the result, it is doubtless hoped, is that readers of the newspapers will either send for the publications referred to or visit the exhibition. The Press statements are distributed a few days before it is intended that they shall appear, and editors are requested to return a card of acknowledgment that they have been so used. We shall probably learn the result of the experiment in some future report of the Smithsonian Institution, to which museum curators in this country will look forward with much interest. Although some of our museums, both national and provincial, already utilise the Press in this direct official manner, we are under the impression that their communications are neither so frequent nor so freely distributed as those of the United States National Museum appear to be; neither are they written with quite the same obvious intention of furnishing easy reading for the average citizen.

EXPLORATION IN THE KARAKORUM.

DR. FILIPPO DI FILIPPI'S paper to the Royal Geographical Society on June 14 is the record of an expedition more thoroughly equipped, from a purely scientific point of view, than any that has yet attacked the many problems still awaiting solution in the dreary solitudes that lie beyond the valley of the upper Indus. To one who knows by experience the labour involved in transferring himself for a few months only, with no more elaborate outfit than a single tent, a geological hammer, and a camera, to the higher regions of the Himalaya, it seems almost incredible that such items should be included in the impedimenta as a complete wireless installation; pilot balloons, with the hydrogen for their inflation carried in sixteen steel cylinders; and other scientific gear; to say nothing of tents for a party numbering one hundred and fifty persons, and the provisions, amounting to some forty-six tons, requisite for a sojourn of many months in that most inhospitable country. Yet the task was brought to a successful conclusion, in the face of every obstacle that Nature in her most inclement mood could oppose to it. We are left to imagine with how great an expenditure of patience and energy, for the modest narrative of the leader of the expedition, Signor Filippo di Filippi, makes light of this aspect of the achievement.

The programme was certainly ambitious. It included a topographical survey of the Karakoram east of the Siachen glacier, where the great Remo glacier was found to possess some of the features of an ice-cap, its upper basin being described as a vast circus filled to the brim with ice, which overflows between the surrounding peaks, while one of its branches sends its waters down the Yarkand river into Central Asia, and another feeds the Shyok, a tributary of the Indus: a series of gravimetric observations designed to connect the work of the survey of India along the southern flanks of the Himalaya with that of the Russians in Turkestan: determinations of longitude by means of wireless time signals transmitted from Lahore: a comprehensive study of the geology, not confined to the main route traversed by the expedition, combined with a collection of anthropological data: and lastly, astronomical and meteorological observations, with complete photographic and cinematographic records.

Leaving Skardu, where it had passed the winter, in February, 1914, the expedition, making its way over passes deep in snow, arrived in the beginning of June on the Depsang plateau, a desolate expanse of minute detritus, at an altitude of 17,400 ft. above the sea, "entirely devoid of vegetation except for occasional patches of a yellowish-green plant which at first view suggests, more than anything else, some malignant disease of the soil." On this plateau, constantly swept by an icy wind, and deluged with storms of hail and sleet, the scientific work of the expedition was carried on until late in August, when the journey to the plains of Russian Turkestan was resumed and successfully accomplished early in November.

The scientific results of this expedition will be awaited with eager interest. They cannot fail to throw light upon the geodetic aspects of the Himalayan problem, which have recently been the subject of much discussion, and on meteorological questions of great moment in India. It will be interesting also to compare the geological results with the observations of Stoliczka, who traversed the same route more than forty years ago, and whose classification of the formations met with in the N.W. Himalaya remains practically unimpaired to the present day.

T. H. D. L.

NOTES.

THE Moxon gold medal of the Royal College of Physicians has been awarded to Prof. J. J. Déjerine, of Paris, and the Baly gold medal to Dr. F. Gowland Hopkins.

WE learn from *Science* that the Board of Estimate and Apportionment of New York City has passed a resolution authorising the issue of 20,000*l.* corporate stock of the City of New York to provide means for permanent improvements at the Brooklyn Botanic Garden, including the completion of the laboratory building and plant houses. This action was taken following the generous offer of Mr. A. T. White, chairman of the Botanic Garden Committee of the Brooklyn Institute trustees, to secure a like sum by private subscription. The amount was subscribed by

Mr. White and the donors of the original endowment of the garden. Plans are now being prepared for the completion of the buildings, only one-fifth of which has been erected.

THE death is announced on July 23 of Dr. Edmund Owen, consulting surgeon to St. Mary's and other hospitals. He was also surgeon-in-chief to the St. John Ambulance Brigade. Dr. Owen was in 1867 appointed demonstrator and in 1876 lecturer in anatomy at St. Mary's Hospital Medical School. In addition to numerous more technical works, he published in 1890 a "Manual of Anatomy for Senior Students." The article on "Surgery" in the current edition of the "Encyclopædia Britannica" was from his pen. He was a member of the council of the Royal College of Surgeons for sixteen years, and a vice-president of the college. He became a member of the British Medical Association early in his career, and in 1883 he was secretary of the Section of Surgery at the Liverpool meeting, from which date he took an increasingly important part in its affairs. In 1906 he delivered the Bradshaw lecture on cancer, and in 1911 the Hunterian oration.

THE following additional lists have reached us of members of scientific staffs on active service with H.M. Forces:—DUBLIN: *Geological Survey of Ireland*:—T. Haigh, professional assistant (chemist and soil analyst), Sergt. 7th Batt. Royal Dublin Fusiliers; H. T. Kennedy, geologist, Lieut. Royal Scots Fusiliers; R. L. Valentine, geologist, Lieut. 8th Batt. Royal Dublin Fusiliers. LONDON: *Geological Survey*:—C. H. Cunnington, geologist, 2nd Lieut.; R. J. A. Eckford, fossil collector, Lance-Corpl.; R. du B. Evans, geologist, 2nd Lieut. (wounded and prisoner); P. A. Frisby, assistant clerk, Sergt.; D. Haldane, fossil collector, Sergt.; W. B. R. King, geologist, Lieut.; R. W. Pocock, geologist, 2nd Lieut.; H. H. Read, geologist, private; J. E. Richey, geologist, 2nd Lieut.; A. P. Stewart, general assistant, private; T. H. Whitehead, geologist, Lieut.—Dr. E. N. da C. Andrade, who held a John Harling fellowship in the University of Manchester at the outbreak of war, and was engaged in physical researches, though not on the teaching staff, is a 2nd Lieut. in the Royal Garrison Artillery.

IN response to the circular letter referring to offers of service connected with the war, sent to fellows of the Chemical Society on July 1 (see NATURE, July 8, p. 523) more than 900 forms have been received, together with many letters and suggestions. In that letter it was stated that in dealing with these replies the council would have the assistance of special committees, each of which would be formed by a kindred society. The following societies are co-operating:—Royal Agricultural Society, Biochemical Society, Society of Chemical Industry, Society of Dyers and Colourists, Faraday Society, Institute of Chemistry, Institute of Metals, Institution of Mining and Metallurgy, Pharmaceutical Society, Physical Society, Society of Public Analysts. Each of these societies will nominate six experts who, together with two members of the council of the Chemical Society, will form a committee to consider and report on matters referred to it by the council. In addition to these special committees, a general committee is in course of formation which will consist of about twenty members, two being nominated by each of the co-operating societies. The function of this general committee will be to deliberate on all questions of general policy with reference, not merely to questions directly relating to the war, but also to all matters on which it is desirable to have the opinion of a body thoroughly representative of every department of chemical science.

IN the course of a statement on the work of the Ministry of Munitions, made in the House of Commons on July 28, Mr. Lloyd George said:—"I have just completed arrangements to constitute an Inventions Branch of the Ministry of Munitions, and I hope it will do for inventions for land warfare what Lord Fisher's Board is doing for naval warfare. The War Office is handing over the whole question of Army inventions to the Minister of Munitions, and careful arrangements are being made to secure that the new branch will keep in close touch both with Lord Fisher's to avoid duplication and overlapping, and also with War Office experts and Army authorities, who must, of course, have an ultimate voice in deciding whether a particular invention is of practical service to the conditions of actual warfare in the present campaign. I have appointed Mr. C. W. Moir, a distinguished engineer, who has already given valuable assistance to my Department on a voluntary basis, to take charge of the new branch, and he will not only have an expert staff to deal with any project that may reach him, but also a panel of scientific consultants to assist on technical and scientific points. I think to save disappointment I ought to say that it ought to be clearly understood that only a very small minority of inventions are of practical value, especially under the stringent conditions of modern warfare. Many projects fail from technical defects, many others, although technically perfect, are unsuitable for the practical conditions of war. The new branch will have justified its existence if one project in a hundred, or even one in a thousand, turns out to be of practical utility in the present emergency."

SCIENCE in Oxford has suffered a further loss by the death of Dr. A. J. Herbertson, of Wadham College, professor of and reader in geography. A native of Scotland, Prof. Herbertson prepared himself for his scientific career by a course of study in Germany, where he graduated as Ph.D. of the University of Freiburg. Appointed reader at Oxford in 1905 and professor in 1910, he was enabled by the liberality of the Royal Geographical Society, and with the support of the University, to establish and equip a department representing not unworthily a branch of natural knowledge which it must be confessed had up to ten years ago received scant recognition in Oxford. It is not too much to say that to the zeal and energy of the late professor is mainly due the flourishing condition of the school of geography now housed in the well-known building which was for so long the abode of the late Sir Henry Acland. He spared no effort in urging upon the University the importance of his subject, whether from the scientific or the historical point of view. He secured the services of able colleagues, and by his own powers of organisation and the unceasing labour which he brought to bear upon his work, he succeeded in vindicating for geography something like its proper place in the studies of the University. Prof. Herbertson had done good service as a member of the Royal Commission on Canals and Waterways, and in 1910 he was president of the Section of Geography of the British Association. His numerous publications are well known to all geographers, two of particular scientific importance being an "Atlas of Meteorology" (with Mr. J. G. Bartholomew) and "The Distribution of Rainfall over the Land." His death took place on July 31, at fifty years of age, after a somewhat protracted period of ill-health.

Under the title of "War, Wounds, and Disease," Sir William Osler has published a very useful little article in the July number of the *Quarterly Review*. He takes for his text a dismal old saying, that "Disease, not battle, digs the soldier's grave." It dug that grave deep for the Walcheren Expedition: 23,000 deaths from disease, against 217 killed in action. Again, in the Russo-Turkish war of 1829, there were 40,000 Russians in the hospitals. Sir William Osler reproduces here a very notable diagram, from an article by Kozlovski, showing the losses from disease, and the losses of killed and wounded, in the Crimean and other wars. We are often told that the Japanese, in the Russo-Japanese war, were notably free from disease; but it appears, from Capt. Culmann's paper in the Journal of the R.A.M.C., vol. xiii., that they had no fewer than 51·4 of their strength on the sick list. In the present war, we are justly proud and thankful that the incidence of disease has been light, thanks to the splendid work of the Army Medical Department and the Army Transport Service. Sir William Osler directs attention to the very large proportion of our wounded who are able to return to their arduous duty; it is no fewer than 60 per cent. Then, after noting the unhappy frequency of illnesses from exposure—pneumonia, bronchitis, rheumatism—he reviews the diseases of infection, most of which, in other wars, have been so terrible: wound-infection, tetanus, gas-gangrene, typhus, cerebro-spinal fever, typhoid, cholera, and venereal disease; and to these he adds a note on cases of over-strained and over-borne "nerves." Happily, he is able to give a very good report of the general health of the Army; but he warns us that the danger is not yet past. "On the whole, the country may be congratulated on the comparatively small part disease has so far played in the great war. There has been no epidemic on a large scale; and with effective measures it may be hoped that we shall escape the terrible experiences of South Africa and the Crimea."

The United States Government in the Philippine Islands has displayed laudable zeal in collecting information on the ethnography of the native races. In 1911 the Governor-General directed that each provincial governor should call together the old men of each tribe and collect all available information about the community in his charge. In reply to this circular about 600 reports of varying interest and value have been received. As a first instalment, Mr. J. A. Robertson, librarian, Philippine Library, Manila, has compiled a monograph on the Igorots of Lepanto, published in the *Philippine Journal of Science* for November, 1914, giving a number of interesting facts on the social life, manners and customs, magic and religion of this tribe. The report is provided with a bibliography and some useful photographs, and may be recommended to ethnologists.

The *Pioneer Mail* of June 18 reports an interesting lecture delivered at Simla, by Capt. Acton, health officer, on snakes and snake-charmers. Many snake-charmers pretend that they owe their immunity to graduated doses of venom, but examination of several individuals failed to verify this statement. The snake-charmer at the Calcutta Zoological Gardens rubs venom into any cut he receives, but he uses permanganate and anti-venene whenever he is bitten. Unless graduated injections could be carried on for a year, or at least six months, they would not be sufficient to resist the huge dose of venom from a cobra's bite. Many of them often carry about the non-poisonous John's earth snake, which is shown to the credulous as double-headed. As a matter of fact, immunity is secured by careful handling of the reptiles, the charmers being taught the art from early youth. Their remedies fall into three classes: snake-stones; drugs and herbs like arsenic, antimony, arislotochia, and opium; invocations and magical formulæ. "It is," he observed, "a well-recognised principle in medical science that any disease which has a host of reputed cures means only one thing—that there is no cure, and that the disease has a small death-rate. About 90 per cent. of the cases survive whatever remedy is employed, and this large percentage gives sufficient excuse for reputed cures."

Some interesting notes on the habits of the four-horned spider-crab (*Pisa tetraodon*) appear in the *Zoologist* for July, by Mr. H. N. Milligan. The author's observations were made upon captive specimens in the aquaria in the Horniman Museum, where this species appears to thrive. The facts recorded refer mainly to the behaviour under the stimulus of fear, the manner of attaching seaweed and other foreign bodies to the shell, and the apparently abnormal relish which the females exhibit for their own eggs, which are devoured almost as soon as laid. Since these are of a bright vermilion colour, and very conspicuous, they would seem to be warningly coloured in so far as other egg-eating animals are concerned. Whether *Pisa tetraodon* habitually devours its own eggs when at large there is at present no means of discovering.

Two admirable essays, the one on the "Home Life of the Kestrel," by Mr. Oswald Wilkinson, the other on "Hobbies in the Vale of White Horse," by the Rev. J. G. Cornish, appear in *Wild Life* for July. In each case a most careful study of the nesting habits and care of the young is given, and these notes are supplemented by a series of very beautiful photographs.

Mr. Wilkinson speaks of wood-pigeons as forming a common article in the dietary of the kestrel. From the great size and weight of this bird, in relation to the kestrel, one cannot resist a suspicion that he is really referring to the turtle-dove. The wanton destruction, both of the kestrel and the hobby, by gamekeepers, gives one cause for rejoicing that at least occasionally they escape the varied and often brutal engines of destruction which, in spite of Preservation Acts, are still in common use. This persecution is the more reprehensible because these birds, like owls, destroy immense numbers of mice and rats, whereas the amount of game destroyed is negligible, as anyone can discover for himself who will take the trouble to examine the pellets thrown up according to the custom of raptorial birds. Not one pellet in ten thousand will be found to contain remains of partridge or pheasant.

The annual report of the Scottish Marine Biological Association for 1914 contains a record of the work done at the Millport Marine Station during that year. The most important investigations to which reference is made in the superintendent's report are those of Dr. J. F. Gemmill on the development of *Asterias rubens*, the detailed paper on which has appeared in the Philosophical Transactions of the Royal Society. Other work of interest is the systematic investigation of a sandy shore undertaken by Mr. R. Elmhirst and Prof. L. A. L. King, and the study of the regeneration of legs in Crustacean Decapods by Mr. J. H. Paul.

Two papers by Dr. C. G. Joh. Petersen make up the Report of the Danish Biological Station, No. xxiii, 1915. The first is on the animal communities of the sea-bottom in the Skagerak, the Christiania fjord, and the Danish waters, and is a continuation of similar studies already published by the author dealing with the communities found in Danish waters. The investigations were made by means of the bottom-sampler designed by Dr. Petersen. The second paper is called, "A Preliminary Result of the Investigations on the Valuation of the Sea," and in it an attempt is made to give numerical estimates of the annual production of various marine organisms, including fishes, in the Kattegat. Whilst undue importance is not intended to be given to the actual figures put forward, the method followed by Dr. Petersen is one which will doubtless be capable of great development in the future.

The July number of the *Quarterly Review* contains an article by Mr. Stephen Reynolds dealing in a general way with the question of the inshore fisheries, but referring specially to the two Departmental Reports published in 1914. The author traces the various causes which have led to the decadence of sea-fishing by small boats on various parts of the coasts of England and Wales. In his opinion the decentralisation of administration brought about by the creation of the District Fishery Committees has had a prejudicial effect. These bodies are not really representative of the fishing interests; and they are, with one or two exceptions, unprovided with sufficient resources to enable them to carry on constructive work, scientific research, or the legal defence of existing fishing rights. Their work has been mainly that of the imposition of restrictions and prohibitions on methods of fishing. The committees are subject to the general control of the central authority (the Board of Agriculture and Fisheries), but the latter possesses no power to initiate legislation. The Inshore Fisheries Committee, which reported in 1914, recommended the practical abolition of the District Committees and the transfer of the actual power of regulation to the central authority. It also recommended various schemes of local organisation and co-operation, and with the assistance of the Development Fund some of these have been begun. Mr. Reynolds describes very shortly the steps that are being taken in Devon and Cornwall to revive and stimulate the smaller fisheries, mainly by means of loans of money to the men. A grant from the Development Fund has also been made to the Fisheries Organisation Society, so that this body has been able to provide a staff for the promotion of the industry.

In the July number of the *Journal of Anatomy and Physiology* Prof. F. Wood Jones makes a welcome contribution to our knowledge of the external genital system of Chelonian reptiles. He regards the external genitalia of turtles and tortoises as representative of a very generalised and primitive type. The commencement of the Chelonian type of copulatory organ is to be seen amongst certain of the Amphibia; the same type occurs as an embryological stage in mammals. The author regards it as probable that "the mammalian stock arose early from some basal meeting point of the Amphibians and the sculate reptiles."

In 1913 Sir Edward Schäfer accepted an invitation from the Leland Stanford Junior University, California, to deliver the Laue medical lectures. He chose for his subject the endocrine glands—that is, the organs of the body which form internal secretions. His name is so closely associated with researches on these glands, especially the adrenal and pituitary bodies, that his choice was an almost obvious one, and those who did not have the opportunity of hearing Sir Edward are now able to read his lectures, as they have been published by the Stanford University in a pamphlet of ninety-four pages, which is simply packed with information expressed in lucid style, and admirably arranged. We can highly recommend the booklet to those who wish to obtain a brief history of our knowledge on this interesting subject, and an authoritative statement of the stage it has reached at present. We note that the author employs his new nomenclature for the substances usually grouped together as hormones; so far the new words have not "caught on," but perhaps the present publication will stimulate other physiologists to adopt them. The same mail brings us another publication in the same series, "The Hæmolymph Nodes of the Sheep," by A. W. Meyer, from the anatomical department of the Stanford University. The subject is not altogether unrelated to the endocrine glands, though it is at present doubtful whether these nodes, or accessory spleens, as they may roughly be termed, form any internal secretion. Dr. Meyer, however, treats the subject mainly from the anatomical point of view, and his paper is illustrated with some very beautiful drawings.

AN interesting contribution to our knowledge of abnormalities in the reproduction of vertebrates has been made by Mr. R. Curtis in a paper on the relation of simultaneous ovulation to the production of double-yolked eggs in the domestic fowl (*Journ. Agric. Research*, vol. iii., No. 5). Such eggs may have (1) the entire set of egg-envelopes common to the two yolks, or (2) the chalaziferous layers separate and the thick albumen common, or (3) entirely separate albumen envelopes and only the membrane and shell common. Of the eggs examined, 71 per cent. belonged to the second type. In only very few cases was there evidence of simultaneous ovulation, and the author believes that "the fusion of follicles and a resulting common blood-supply is by no means the usual cause for the production of a double-yolked egg." In the Report of the Maine Agric. Exp. Station for 1915 (pp. 65-80) Dr. R. Pearl and Mr. F. M. Surface describe a cow which assumed some of the secondary characters of the male, developing thickness of neck and smoothness of rump, and also behaving in many respects like a bull. This animal had been, before the strange change, a normal cow, having borne three calves and shown a high milk record. Post-mortem study showed cystic degeneration of the ovaries in which no corpora lutea were being formed. Hence the authors conclude that the corpus luteum is of importance in maintaining female secondary characters in full development.

WE have received a copy of a paper on the fungus diseases of *Hevea brasiliensis* contributed by Mr. T. Petch, Government mycologist, Ceylon, to the International Rubber Congress held at Batavia yast year. It is reassuring to read that notwithstanding the vast areas under Hevea cultivation, often under bad conditions, no very serious parasitic fungus has as yet been noticed. *Fomes semitosus*, the root disease, first recorded by Ridley at Singapore in 1904, which was much feared, is proving to be of minor importance as the plantations increase in age and as the jungle stumps on which it flourishes disappear. The stem diseases, of which six have been recorded, are perhaps the most dangerous. Three of these, pink disease (*Corticum salmonicolor*), die-back (caused especially by *Botryodiplodia theobromae*), a well-known cacao disease, and canker due to *Phytophthora faberi*, are especially to be feared. It is suggested that Bordeaux mixture may prove effective as a preventive to canker.

THE annual report of the agricultural and horticultural research station of the University of Bristol, otherwise known as the National Fruit and Cider Institute, at Long Ashton, contains a series of papers on cider and perry, mainly by Prof. B. T. B. Barker and Mr. Otto Grove; papers on the treatment of plant disease, by Mr. A. H. Lees; on economic mycology, by Mr. S. P. Wiltshire; on fruit culture trials, by Prof. Barker; and on soils and manures, by Mr. C. T. Gimingham. Among these papers one on the use of pure yeast in the fermentation of cider by Mr. Grove, and a note by Mr. Gimingham on the use of the waste from saw-mills as a source of potash have a general interest. The fact that the ash or flue-dust from saw-mills which burn wood as fuel contains from 5 to 9 per cent. of potash, is not generally realised, and no attempt has been made hitherto to store or utilise this material, which certainly has a manurial value, especially at the present time. In September last the Board of Agriculture and Fisheries organised a series of experiments on the preservation of fruit and vegetables by drying, canning, and other methods, and preliminary experiments were made by Dr. Hamilton at Studley College, and by Mr. C. S. Martin at Dunnington Heath. This work has now been developed, and two experimental factories are being carried on at Dunnington Heath and Broom Junction.

A CATALOGUE of earthquakes felt in the Philippine Islands during 1914 has been issued by the U.S. Weather Bureau. The year was apparently uneventful, the total number of shocks recorded in the islands being 146. None of the earthquakes was of destructive strength, and only twenty-nine were of intensity above the fourth degree of the Rossi-Forel scale. As in all distinctly seismic countries, many of the disturbed areas were extremely elongated in form. The Philippine earthquakes are, however, peculiar in possessing large disturbed areas. For instance, the average area disturbed by earthquakes of intensity 4 is 9660 square miles. In Great Britain, the corresponding figure is 260 square miles.

THE refined methods of modern seismology are well exemplified in a paper by Prince Galitzin, presented to the Paris Academy of Sciences on June 21 (*Comptes rendus*, vol. clx., p. 810), dealing with the earthquake widely recorded on February 18, 1911. This disturbance has been prevented from falling into oblivion by the fact that the survey work of a Russian officer has brought to light the simultaneous occurrence of a cataclysmic land slide at Sarez, a situation well within the area of the epicentre as determined from the records obtained at Tashkent, Tiflis, and Pulkowa. It is easy to calculate the energy (E) liberated in this catastrophe from estimates of the weight of the disrupted mountain and the average vertical fall, whence in c.g.s. units $E = 2{\cdot}1$ to $6{\cdot}0 \times 10^{23}$ ergs. Prince Galitzin next determines the energy by means of the Pulkowa seismographic records, and obtains finally $E = 4{\cdot}3 \times 10^{23}$ ergs. The two values are of precisely the same order of magnitude; hence the conclusion is drawn that the landslip at Sarez was the cause, and not the effect, of the earthquake of February 18, 1911, which thus presents a unique case where the energy liberated at the epicentre, here identical with hypocentre, is known.

THE Department of Agriculture and Technical Instruction for Ireland has reissued the explanatory memoir of the Geological Survey of Ireland, illustrating parts of the counties of Armagh, Fermanagh, and Monaghan (H.M. Stationery Office, Dublin, 1914; pp. i–iv+26; coloured map; price $3\frac{1}{2}d.$), The memoir describes the country around the town of Monaghan, one-inch map sheet 58. The issue of a larger and cheaper edition has provided an opportunity to add a chapter on the relation of the soils to agriculture in the district, and to describe the drumlins, here so well developed. The provision of a small-scale coloured map of the "solid" geology marks an important advance on the earlier edition. Plate ii., which should face p. 16, is absent from the copy we have examined.

The report of the Fernley Observatory at Southport for the year 1914, prepared by Mr. Joseph Baxendell, meteorologist to the Southport Corporation, gives results of considerable interest. The observations have been systematically continued for the last forty-three years, and the values give a good average for intercomparison. A table is given showing the diurnal variation of the winds from different directions for the whole year, based on the observations of fifteen years to 1913, and a diagram shows the summer wind-direction frequencies for the same period. The great prevalence in summer of sea winds, from west and north-west, is well indicated, and there is a much greater prevalence of these winds in the day than in the night. Detailed tables of the several meteorological elements are given for 1914. The warmest month was August, with a mean temperature of 60·6°, which, however, is only 0·7° warmer than July, while the coldest month is January, with the mean temperature 39·9°. The temperature during the year ranged from 80° to 22°. The rainfall for the year was 32·02 in., and the wettest months were July and December, the percentage of the average being respectively 159 and 165. The brightest month was June, with 234 hours' sunshine, whilst April and August were very nearly as bright.

Vol. xxxv., part i., 1913, of the Annals of the Royal Central Office of Meteorology and Geodynamics of Rome contains a long memoir by Prof. Palazzo describing magnetic observations which he took during June, July, and August of 1913 in the Italian colony of Eritrea bordering on the Red Sea. The principal instruments employed were a magnetometer and dip circle by Dover. Observations were taken at sixteen stations situated between 14° 47′ N. and 15° 47′ N. One of the stations was on an island in the Red Sea, the others on the mainland, mostly at considerable heights, in one case 2410 metres above sea-level. The results are summarised on p. 75. A chart at the end shows the stations, and includes isogonals for 1° 30′ to 1° 50′ W., isoclinals from 11° 0′ to 13° 0′ N., and lines of equal horizontal intensity. The isoclinals are nearly parallels of latitude. On p. 89 there is a record of results by other observers in Eritrea. At Massaua (Massowah), on the Red Sea, there were in all results from eight observers, including Prof. Palazzo, the earliest going back to 1839. Conclusions are drawn from these as to the secular change. A summary of the results also appears in a short paper by Prof. Palazzo in the *Rendiconti Accademia dei Lincei*, January, 1915.

The July number of the *Journal* of the Röntgen Society contains the paper which Mr. F. Harrison Glew read before the Society in April, describing a new mechanical effect of the α rays from radio-active bodies. Mr. Glew finds that if a very thin strip of mica has one side exposed to α rays for a week or two the strip is bent, the side exposed to the rays becoming convex and displaying iridescent colours. In one experiment a strip 2 mm. by 11 mm. and 0·01 mm. thick was exposed for a month to the α rays coming from a mica-covered capsule containing two milligrams of mesothorium. The strip was supported at one end so as to be 3 mm. above the cover of the capsule. It was found to have acquired a curvature equal to that of a circle of radius 48 mm. and required a weight of 460 milligrams applied to its middle point to straighten it. When reading his paper Mr. Glew suggested that the α particles arrested by the mica existed as occluded helium in the strip, an opinion which has since been verified by Mr. J. H. Gardiner, who on heating a strip *in vacuo* obtained the helium spectrum.

The U.S. Department of Commerce has published a second edition of Circular No. 20 of the Bureau of Standards. The circular presents briefly, in its first section, the principles underlying the construction and operation of commercial electrical measuring instruments. This is followed by a particularly useful section on the performance of such instruments; the subjects discussed include accuracy, sensitivity, reliability, the effects of temperature change, temperature-coefficients, the effects of stray magnetic and electrostatic fields, the effects of imperfect elasticity of springs and of friction, and the construction of scales. The information on the temperature-coefficients of voltmeters and ammeters is very useful, and methods are suggested for compensating for ordinary temperature changes. The last section contains valuable hints on the testing of instruments; it discusses in detail the application of the potentiometer to the measurement of voltage and current. Owing to its smaller temperature-coefficient, the Weston portable cell of the unsaturated type is recommended as being preferable to the Weston normal cell, in which saturated solution is used. The circular may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C.

The valuable reports and other publications issued by the British Fire Prevention Committee have frequently been referred to in these columns. The war emergency work accomplished by the committee during the past twelve months has been of a very extensive character, and is a remarkable example of what can be done entirely gratuitously by voluntary workers. The following are special features of the work dealt with by the committee during the first year of the war :—*Fire Survey Force* : At the outbreak of war, the committee formed a special Fire Survey Force of 100 surveyors to undertake at short notice any fire surveys required by the Government in an honorary capacity. Above 900 establishments taken over for war emergency work all over the country were surveyed by this force, with a total of more than 40,000 beds. Latterly re-surveys are made in cases of special fire risk. *Fire Warnings* : The warning service embraced the preparation and free issue of a large number of public "fire warnings" in connection with the war emergency, disseminated by the committee in the form of posters, circular letters, or as notices reproduced by the Press, etc. The total issue of posters and like publications exceeds 200,000. *Fire*

Service Force: The Special Fire Service Force, organised by the committee at the outbreak of the war, and comprising ex-fire brigade officers and firemen, was originally brought into such a form as to make 300 firemen readily available for mobilisation in sections within forty-eight hours. The results of the work of the committee have been far-reaching. The great care taken by the public on simple, sensible, and inexpensive lines to prevent outbreaks of fires and to meet them with organised self-help is extraordinary, and must affect the reduction of the fire loss after the war, as it has during the war.

A copy of the thirteenth half-yearly volume of the Journal of the Institute of Metals has been received. For the most part the volume is a record of the papers read at the recent London meeting of the institute, to many of which attention has been directed already in these columns. In addition, there is an important contribution on "Bronzing Processes Suitable for Brass and Copper," by Mr. T. J. Baker, read on January 26 last at the Birmingham section of the institute. The part of the book containing abstracts of foreign scientific papers dealing with copper, brass, and other non-ferrous metals is remarkably complete in view of the difficulty of obtaining access to Continental periodicals. The volume contains 471 pages, ten full-page plates, and numerous illustrations in the text. It is issued under the editorship of Mr. G. Shaw Scott, and published by the Institute of Metals, Caxton House, Westminster, S.W., from whom, or through any booksellers, copies can be obtained, price 21*s*. net.

The Cambridge University Press has in the press, in the "Cambridge Travel Books" series, "The Earliest Voyages round the World, 1519–1617," and in the "Cambridge Public Health" series "The Spread of Tuberculosis," by Dr. L. Cobbett. The following books in the latter series are in preparation:—"Ticks as Carriers of Disease," Prof. G. H. F. Nuttall; "Serum Diagnoses," Dr. C. Browning; "Tropical Hygiene," W. J. R. Simpson; "The Purification of Water in Sedimentation, Filtration and Precipitation," Dr. A. C. Houston; "The Purification of Water by Ozone and Chlorine, and Domestic Filters," Prof. G. Sims Woodhead; "The Principles and Practice of the Dilution Method of Sewage Disposal," Dr. W. E. Adeney; "Disinfection," Dr. C. W. Ponder; "Housing in Relation to Public Health," Dr. C. J. Coleman; "School Hygiene," Dr. E. T. Roberts; "Soils, Subsoils, and Climate in Relation to Health," G. Walker; "Offensive and Harmful Trades," Sir T. Oliver; "Meat Inspection," Dr. W. J. Howarth and T. D. Young; "Vital Statistics," R. Dudfield and G. U. Yule; "Foods, Sound and Unsound," Dr. H. C. Haslam.

OUR ASTRONOMICAL COLUMN.

An Association for the Observation of Mars.—During the past opposition of Mars, Prof. W. H. Pickering issued a series of monthly reports dealing with the planet; these were first published in *Popular Astronomy*, then reprinted, and distributed in pamphlet form; in this way a system of co-operation by correspondence was established. This proved so mutually advantageous that Prof. Pickering is now attempting to organise an association to operate during the coming opposition of next February. Details are given in a circular letter distributed with Mars Report No. 9. The particular advantage to be derived from collaboration is continuity of record, which can only be secured in this case by having observers uniformly distributed in terrestrial longitude in consequence of the small difference between the Martian and terrestrial days. Weekly drawings, reduced micrometric observations, if possible, and a monthly report are desired from each observer. Regular observation should begin next January, but observations of Syrtis Major in October, November, and December would be of exceptional interest.

The Pole Effect in the Iron Arc.—Some results of further investigations carried on by Dr. St. John and Mr. Babcock, at the Mount Wilson Solar Observatory, in continuation of their important work on the minute differences of wave-length of lines in the spectrum of the iron arc when sources near the middle and near the negative pole are compared, have been communicated to the National Academy of Sciences, U.S.A. (Proc., vol. i., p. 295, 1915). It has been found that the wave-lengths of these sensitive lines are not affected by wide variations of *density* of the radiating vapour; change of *temperature* in the electric furnace does not affect the wave-lengths; with the enclosed arc the effect does not occur at pressures below 10 cm. of mercury; and, unlike the pressure shift, the pole effect does not appear to vary with wave-length. As the pole effect may amount to upwards of 0·02A, it is obviously important that it should be taken into consideration in re-determination of wave-lengths in international units. In order to eliminate the effect, the light should be taken from a point more than 2 mm. distant from the pole.

The Harvard Observatory.—Anything concerning this famous institution cannot fail to be of interest, and thus we welcome a reprint from the Harvard Alumni Bulletin, March 10, 1915, of two articles, one by the director, Prof. Pickering, and the other over the initials "J. D. M.," dealing with the observatory and its work respectively. Founded in 1840 by W. C. Bond, with the help of thirty subscriptions of 20*l*. each, the endowments now amount to 200,000*l*., and the annual income exceeds 10,000*l*., yet, we are told, "there has never been a time . . . when funds . . . were needed more than they are to-day." In addition to the well-known Arequipa Station in Peru, where the 24-in. photographic doublet has been mounted, a station in Jamaica has recently been founded for visual work. No fewer than seventy complete quarto volumes of Annals have been published and eight others are in preparation, whilst about 200 circulars have been issued. Concerning the progress of the Draper Catalogue, we are informed that down to March 1, 1915, Miss Cannon had classified no fewer than 188,350 stellar spectra.

Annual Review of Astronomy (1914).—M. P. Puiseux has contributed to the *Revue générale des Sciences* of July 15 another of the useful annual reviews we have learned to expect from his pen. In referring our readers to this article, attention may be especially directed to the reference under the heading "Comets" to Innes's cosmological hypothesis and the objection he raises that it leaves unexplained the fact of the small eccentricities and inclinations of the planets and satellites. In the section on nebulæ prominence is, of course, given to the application of interferential methods to the study of the spectrum of the Orion nebula by Fabry, Buisson, and Bourget, work which, among many other interesting results, revealed the existence of the element of atomic weight 3, previously predicted on theoretical grounds by Prof. Nicholson.

MARINE BIOLOGY AT PLYMOUTH.

IN the latest number (vol. x., No. 4) of the Journal of the Marine Biological Association there are two papers of very considerable interest. Of these, the first deals with experiments in the rearing of plankton animals (Crustacean larvæ and Copepoda) which are of importance as a food supply for fish. The author is Mr. L. R. Crawshay. Plymouth Marine Station is justly celebrated for the invention by its director, Dr. Allen, of the method of rearing various types of marine larvæ by feeding them with pure cultures of the diatom Nitzschia. By this method the larvæ of Echinodermata, Mollusca, and Annelida have been reared until they attained the adult condition. Mr. Crawshay has endeavoured to extend the method to Crustacea. He has made some interesting discoveries. Thus he finds that in spite of sterilised water and abundant food, Copepoda live a very short time unless the culture flask be kept cool and the temperature remains constant. Then he finds that the harmful action of bacteria has been much exaggerated. There are only one or two varieties which are fatal to Copepoda, but these are of infrequent occurrence. When he had arranged for a good food supply and a constant temperature, he was able to keep the delicate pelagic form, *Calanus finmarchicus*, alive for months, and to rear the nauplii of Pseudocalanus through all stages of development until the attainment of the adult condition. When this method has been perfected it will be possible to study the life-histories of the economically important Copepoda in detail in the laboratory, instead of, as now, piecing the development together from scattered observations of plankton.

The second paper to which we wish to direct attention deals with twin larvæ of the starfish Luidia. These larvæ developed from eggs which were artificially fertilised at Plymouth. When the eggs had attained the blastula stage they were sent in sea-water in a thermos flask to the author, Dr. Gemmill, lecturer in embryology in the University of Glasgow, by whom they were reared further. Dr. Gemmill ascribes the formation of twins to the shaking which the blastulæ endured on the journey from Plymouth to Glasgow; this seems to have caused partial rupture of the blastulæ at a time when the tissues are equipotential, and the partially separated fragments have each striven to produce a perfect larva.

Besides these papers the volume contains a valuable list of the Annelida found in the neighbourhood of Plymouth by Dr. Allen. There is also a paper by Miss Olwen Rees, which we hope is the first of a series, which records the results of a systematic investigation of the internal anatomy of the British members of the Actinozoon family Sagartidæ. Too often accounts of the internal anatomy characteristic of a group have been founded on the dissection of a single "type" to the structure of which the other members have been assumed to conform.

At a time when the war threatens the continued existence of such celebrated stations as Naples and Trieste, it is important to be reminded of the asset which British zoology possesses in the Plymouth Station, and of the necessity of making every effort to sustain it during this arduous time.

E. W. M.

THE TAPPING OF RUBBER TREES.

THE Ceylon Department of Agriculture has issued a number of circulars on the tapping of individual and groups of Hevea trees and the effect of such operations on the storage of plant food. All the experiments and observations are based on *Hevea brasiliensis*, most of the trees dealt with being of considerable age. The papers are by Mr. T. Petch (mycologist) and by Mr. L. E. Campbell (rubber research chemist).

The first circular gives the results obtained by tapping one old Hevea tree for four years and nine months. The tree was planted in 1877, and is surrounded with other trees of the same species. It is a tree of an unusual type in so far that the main stem branches into two at about 10 ft. from the ground. In a way it is a famous specimen, and has been much photographed in past years. In four years nine months this tree has given 392 lb. 7 oz. of dry rubber: a most phenomenal crop. The rubber was obtained from the original and renewed bark on the basal portion of the stem.

The other circulars dealing with Hevea tapping results cover two distinct periods; first from 1911 to 1913 and second 1914. Experiments were made to determine the yield obtained by different frequencies of tapping and by different systems. Pricking and paring knives were also experimented with. The account of experiments for the period 1911–13 is largely statistical, very few deductions being drawn from the tabulated statements. The account of results for 1914 forms a continuation of those already referred to. While it would be too early to draw trustworthy practical conclusions from the results obtained, there are one or two points which become evident to the reader. They confirm previous results in so far that the yield per tapping increases as the time interval between consecutive operations is increased. The yield, however, in a given time is greatest with the more frequent tapping. It is further suggested that prolonged tapping on a single section, when cuts are 2 ft. apart, has a detrimental effect on the yield.

Reference is made to the fact now generally recognised that results of tapping experiments hitherto conducted are of little value because no count was taken of the varying capabilities of different tappers who do the work. In the circulars we now review this cause of variation was allowed for.

Mr. Campbell's circular on the effect of tapping on the storage of plant food in *Hevea brasiliensis* is exceptional in character. In tapping operations the living cortex of the tree is cut away in order that the latex may freely exude. This destruction of living tissue is made good by rapid cambium activity which soon results in the production of a thick renewed cortex, except in those cases where the tappers have damaged the cambium. The renewed bark is conceived to be formed largely at the expense of reserve foods in the plant. Mr. Campbell has selected the starch grains as a reserve food, the fluctuation in quantity of which might indicate the varying effects of tapping operations. The author made a study of the bark of tapped areas, and by an ingenious method determined the number of starch grains in a given area. The work indicates that the effect of careful tapping is localised. This is not in accordance with the general view on the subject. The local effects are especially apparent in a horizontal direction, and the author suggests that by changing tapping from one part of the tree to another at intervals the resting period of each area so tapped is nearly as effective as if the whole tree were rested. The "change over" system is becoming quite common on a number of Ceylon estates.

H. W.

ON BEAUTY, DESIGN, AND PURPOSE IN THE FORAMINIFERA.[1]

In the dawn of history the Tartars in their flight before the victorious army of Ladislaus, King of Transylvania, scattered money as they fled, trusting to the apparently already established instincts of the Teuton soldiers that their pursuit would be thereby arrested. But King Ladislaus prayed that this money might be turned into stones, and his prayer was immediately granted. Hence the Nummulites. This, at any rate, is the account given of the matter in the sixteenth century by the learned Clusius,[2] and it is probably the first mention of the Foraminifera in print. The equally learned Strabo, however, had recorded that the Egyptian Nummulites were the petrified remains of beans left behind them by the builders of the Pyramids,[3] in spite of the explicit statement of Herodotus that the Egyptians never grew or ate beans in any form.[4] This Nummulite, which rightfully claims to be the earliest recorded Foraminifer, is also the highest and most complex of its order, and it was based upon his study of this family that Dr. Carpenter in 1885 claimed for the Foraminifera that they are the most highly specialised and structurally developed of the Protozoa.[5] "They stand at the summit of a long branch of the whole tree of life,"[6] and have with perhaps the single exception of the Globigerinidæ, played a more important part in the building up of vast tracts of the earth's surface than any other organism. The Nummulitic Limestones (Fig. 1) stretch in a broad band, in many places several thousands of feet in thickness, across Europe and Northern Africa, and through Asia by the Himalayas to China, the matrix, containing the perfect fossils, being a rock formed of their comminuted remains. The deposit is characteristic of the Eocene period; but the Nummulites have now died out, being represented to-day in the tropics by a single living species, *N. cummingii*.

FIG. 1.—Section of Nummulitic Limestone.

Coeval with the Nummulites, and closely approximating to them in importance as world-builders, is the genus Alveolina, which is found in the same beds, either gradually replacing them, or sometimes taking their place with startling suddenness in the strata. Off the extreme point of Selsey Bill, in Sussex, the locally named "Mixon reef" rises at the summit of the Eocene deposits, composed almost entirely of fossil shells of *A. boscii* (Fig. 2), indistinguishable from the living shells of the species which abound to-day in the shallow water and littoral sands of Australian and other tropical shores.[7]

With all respect, however, to the recent utterances of its most noteworthy protagonist,[8] the Nummulite is a mere parvenu compared with the species *Spirillina groomii*, discovered in the Cambrian rocks of Malvern by Chapman,[9] and rediscovered by Arthur Earland and myself alive in the shallow waters of the west of Ireland,[10] which probably represents the earliest specific form of life to be found living at the present day. Even the conservative little Lingula shell has become slightly modified since its earliest ancestors wallowed in Cambrian mud a hundred million years ago.[11]

I have alluded to the Globigerinæ, which are to-day forming a geological deposit of unknown thickness over 48 millions of square miles in the modern oceans.[12] Agassiz has observed that "no lithological distinction of any value has been established between the chalk proper and the calcareous mud of the Atlantic,"[13] and it has been estimated that the time

FIG. 2.—*Alveolina boscii*, Defrance.

occupied by the deposit of the English chalk, arguing by the rate at which the Atlantic ooze is formed (which is about one foot in a century), must have been 150,000 years.[14]

As Maury has picturesquely said, "The sea, like the snow-cloud, with its flakes in a calm, is always letting fall upon its bed showers of microscopic shells."[15] These are some of the Foraminifera that

[1] From a discourse delivered at the Royal Institution on Friday, May 21, by Mr. Edward Heron-Allen.
[2] "Caroli Clusii et aliorum epistolae," Ep. xxxvii. Paris (c. 1550).
[3] Strabo, "Geographica," bk. xvii., cap. i., 34.
[4] Herodotus, "Euterpe," ii., 37.
[5] W. B. Carpenter, "On the Structure of Orbitolites." Journ. Quekett Micr. Club, ser. 2, vol. ii., p. 102.
[6] P. Chalmers Mitchell, Art. "Evolution" in "Encycl. Britannica," 11th ed., vol. x., p. 35. 1910.

[7] E. Heron-Allen and A. Earland, "The Foraminifera in their rôle as World-Builders." Journ. Quekett Micr. Club, ser. 2, vol. xi., pp. 9-11, 1913.
[8] R. Kirkpatrick, "The Nummulosphere." London, 1913, etc.
[9] F. Chapman, "Foraminifera from an Upper Cambrian Horizon of the Malverns." Q. Journ. Geol. Soc., p. 257. 1900.
[10] E. Heron-Allen and A. Earland, "The Foraminifera of the Clare Island District." Proc. R. Irish Acad., vol. xxxi. (Clare Island Survey part 64), p. 107, pl. ix., figs. 2, 3. 1913.
[11] Cf. E. Heron-Allen, "Selsey Bill." London, 1911, p. 24.
[12] Sir J. Murray, "The Ocean," p. 207. London. 1913.
[13] A. Agassiz, "Three Cruises of the *Blake*," vol. i., p. 150. London 1888.
[14] A. J. Jukes-Brown, "Handbook of Physical Geology," p. 130. London, 1884. The rate of deposition varies slightly according to depth. See Murray, *op. cit.*, p. 224.
[15] M. F. Maury, "The Physical Geography of the Sea," 15th ed., p. 322. London, 1874. Cf. H. N. Moseley, "Notes of a Naturalist on the *Challenger*," p. 582. London, 1879. "The dead Pelagic animals must fall as a constant rain of food upon the habitation of their deep-sea dependants."

may be washed out of any ordinary lump of Upper Chalk. In many localities on a smaller scale the Foraminifera may be seen occupied in this process of world-building. The shore of Dog's Bay, in Connemara, is composed of sands in which no grain of sand has a place. As far as the eye can see, and as deep as man can dig, preserving any measure of self-respect, the littoral deposit consists of pure Foraminifera extending far above high water-, and far below low water-marks. In a lesser degree the same thing may be seen a little to the north, just south of Emlagh Point, while anyone who has taken the trouble to examine the grit shed in disconcerting quantities by a new Mediterranean sponge must realise what masses of Foraminifera make up the bulk of the shallow water sands in those latitudes.

Such, then, shortly is the occurrence of the Foraminifera, which, leaving on one side the doubtful record of *Strombus lapidus* by Gesner in 1565,[16] which Prof. Rupert Jones identified as a Vaginulina,[17] make their first appearance in the Micrographia of Hooke in 1665[18] as "Figures observed in small sand." He figures one of them, which is clearly the common shore form *Rotalia beccarii*. In 1702 Prof. Plimmer's "Immortal Beadle,"[19] Antony van Leeuwenhoek, in a letter to the Royal Society,[20] figured the equally common and related form *Polystomella striato-punctata* "from out of the stomach of a shrimp," in which happy hunting-ground Reade recorded the presence of Foraminifera more than 150 years later.[21] There can be no doubt that they play an important part in determining the movements of many of our most important food fishes.[22]

Since the day of Leeuwenhoek the Foraminifera have continually engaged the attention of zoologists. Before Linnæus we have the works of Plancus,[23] Ledermüller,[24] and others, but between the time of Linnæus and the early years of the last century the era of monographs began; Walker and Boys in England,[25] Fichtel and Moll in Germany,[26] Lamarck in France,[27] Soldani in Italy,[28] have left behind them specialist works upon the Foraminifera which still form (sometimes to our serious embarrassment) the foundations of our study.

The recent period may be said to have commenced in 1819, when the father of Alcide d'Orbigny wrote to the geologist Fleuriau de Bellevue that his son was studying "microscopic cephalopods" from the shore sands at Esnandes, near their native town, La Rochelle.[29] After this, captains of ships and travelling naturalists supplied young d'Orbigny with a mass of material from all parts of the world, resulting in the publication of his Tableau Méthodique,[30] in which a vast number of species both recent and fossil were recorded. His records from Madagascar in particular are of supreme interest for us, for we have recently examined a series of dredgings from Kerimba, on the adjacent African coast,[31] in which we have rediscovered most, if not all, of his Madagascan species. He recorded in particular the species *Pavonina flabelliformis* (Fig. 3), which after 1826 was entirely lost sight of for half a century, when it was rediscovered in Madagascan sand by Brady.[32] It is quite one of the most beautiful of the Foraminifera, whether viewed as an opaque object or by transmitted light.

The true nature of the Foraminifera was not, however, understood until Dujardin in 1835[33] separated them from the Cephalopods, among which they had been grouped on account of certain superficial characteristics, and their extensile bodies. From this time onward the literature of the Foraminifera has expanded into a vast body of memoirs and monographs in every European language.[34]

The Foraminifera are to be found in all parts of the world and under all conditions, on the shore, in deep-sea soundings and dredgings, and floating at all depths of the ocean, whence they are taken in tow nets, and they divide roughly into two great classes, the Calcareous, which secrete from the surrounding waters a delicate and beautiful shell of carbonate of lime, and the Arenaceous, which build their shells out of sand-grains, sponge-spicules, and other fortuitous materials, often affording remarkable indications of phenomena of purpose and intelligence to which I shall presently refer. A single species, *Carterina spiculotesta*, builds its shell of fusiform calcareous spicules, secreted by the animal itself by a process which is at present entirely obscure. A remarkable feature of the organism is that whereas the resulting spicules on the upper surface follow the convolutions of the chambers, on the under side they are turned inwards so as to converge towards the central umbilicus.

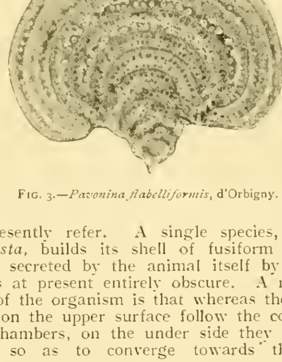


FIG. 3.—*Pavonina flabelliformis*, d'Orbigny.

The distinction between the calcareous and arenaceous shells is purely artificial, isomorphs existing between the three great classes, the hyaline (or perforate), the porcellanous (or imperforate), and the sandy (or arenaceous). A typical isomorphism is represented by the three genera Cornuspira, which is porcellanous, Ammodiscus, which is arenaceous, and Spirillina, which is hyaline.

One of the most beautiful and delicate of the arenacea is *Reophax scottii*, which is built entirely of minute flakes of mica cemented together at the edges.

Polymorphina regina is a very handsome representa-

16 C. Gesner, "De omni rerum fossilium genere, gemmis," etc. (Last sect. p. 165). Tiguri, 1565.
17 T. Rupert Jones, Q. Journ. Geol. Soc., pl. xxxiv., fig. 5, *Vaginulina laevigata*. 1884.
18 R. Hooke, "Micrographia," p. 80. pl. v., fig. x. London, 1665.
19 H. G. Plimmer, *Bedellus immortalis* (Presidential Address), J. R. Micr. Soc., p. 121. 1913.
20 A. van Leeuwenhoek, "Sevende verfolg der Brieven," p. 196, pl. opp., p. 191, fig. 7. Delft, 1702
21 J. B. Reade, Trans. Micr. Soc., vol. ii, pp. 20–24. London, 1849.
22 F. Pearcey, "On the Movements and Food of the Herring," Proc. Roy. Phys. Soc., Edinburgh, vol. viii, p. 389. 1885.
23 Janus Plancus, "De conchis minus notis liber." Venice, 1739. 2nd ed., Rome. 1760.
24 M. F. Ledermüller, "Mikroskopische Gemuths- und Augen-Ergötzung." Bayreuth, 1760–61.
25 Walker and Boys, "Testacea minuta rariora." London, 1784.
26 Fichtel and Moll, "Testacea microscopica." Vienna, 1798.
27 J. B. de Lamarck, "Système des Animaux sans Vertèbres." Paris, 1801.
28 A. Soldani, "Testaceographia." Senis, 1789–98.
29 C. d'Orbigny, Journal de Physique, vol. lxxxviii., p. 187. Paris, 1819.
30 A. d'Orbigny, "Tableau Méthodique de la Classe des Rhizopodes," Ann. Sci. Nat., vol. vii., pp. 245–314. Paris, 1826.
31 E. Heron-Allen and A. Earland, "The Foraminifera of the Kerimba Archipelago," Trans. Zool. Soc. (Lond.), pt. i., vol. xx. (1914), p. 363; pt. ii. (1915). (In the press.)
32 H. B. Brady, *Challenger* Reports, vol. ix., "Foraminifera," p. 375, pl. xlv., figs. 17–21. 1884.
33 F. Dujardin, "Observations nouvelles sur les pretendus Céphalopodes Microscopiques," Bull. Soc. Sci. Nat. France, No. 3, p. 36. 1835.
34 C. D. Sherborn, "A Bibliography of the Foraminifera." London, 1888.

tive of a genus which is frequently found attached to sand grains and shells by fistulose processes (Fig. 4).

The Globigerinæ, to which we have already alluded, are often merely stages in the life-history of *Orbulina universa*, which we may break open and find in it the earlier Globigerina.

Pulvinulina is represented by *P. pauperata* (Fig. 5).

The object and significance of this variety of beautiful forms are entirely obscure, but have engaged the attention of many biologists both in the Foraminifera and in the Radiolaria.[35] It must be remembered that a Foraminifer, like a Radiolarian, is a unicellular

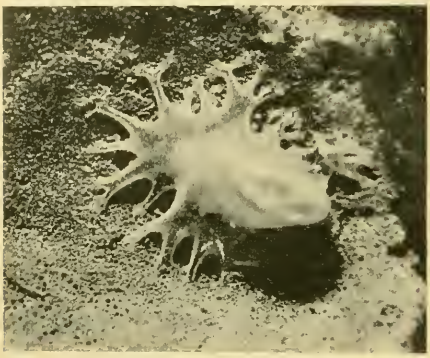


FIG. 4.—*Polymorphina rotundata*, d'Orbigny, fistulose and adherent.

animal consisting solely of a microscopic globule of undifferentiated protoplasm, vivified by a nucleus the functions of which are little understood, but which are essential to the existence of the animal.

This protoplasm is extended in the form of fine filaments which intermingle freely with one another, called pseudopodia, and their mechanical functions are locomotion and the capture of food. I have made a series of photographs of a fine Gromia which emerged from the mud in one of my tanks, climbed up the glass until it encountered a sea-weed stem, up which it crawled, and finally drew itself off on to the glass again by means of its pseudopodia. It then got lost,

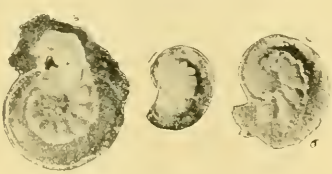


FIG. 5. *Pulvinulina pauperata*, Parker and Jones.

but on punching a hole in a piece of black paper which was then gummed on to the glass and a strong beam of light directed through it, it came back into the circle of light, apparently indicating that these creatures are sensitive to light.

The other important function is the capture of food, which is caught outside the shell and usually drawn into it, as in this case of *Miliolina durrandii*, which has ingested a smaller Foraminifer and a diatom.[36]

[35] Cf. F. Gamble in Ray Lankester, "A Treatise on Zoology," pt. i., fasc. 1, pp. 130, 131. 1909.

[36] E. Heron-Allen, "Contributions towards the Study of the Bionomics of the Foraminifera," Phil. Trans. Roy. Soc. (Lond.) 1915.

It is a most significant, and at present unexplainable, fact that these minute protoplasmic globules secrete such varied materials for the formation of their shells from the surrounding medium as carbonate of lime, silica, and even sulphate of strontium, but the nature and character of their protoplasmic bodies which perform this function defies analysis or definition in the present state of our knowledge.

Their life-cycles have been carefully studied by Lister,[37] Schaudinn,[38] Winter,[39] and others, and the fact has been established that most, if not all, Foraminifera exhibit the phenomenon called dimorphism (that is to say, they start with a large or a small central chamber), and that the small-chambered (or microspheric) individuals reproduce themselves by means of amœbulæ expelled from the shells producing the megalospheric young, whilst the large-chambered (or megalospheric) individuals discharge flagellispores which conjugate with the flagellispores of other individuals and producing microspheric young, recommence or continue the life-cycle.

Within the last few months, owing to the initiative and manipulative skill of Mr. J. E. Barnard, a new and very striking method of investigation has been developed which not only reveals the internal structure of Foraminifera without the need of cutting sections, and so destroying the specimens, but may have far-reaching results when applied to the study of the living protoplasmic bodies. This is the application of the X-rays to the shells, the results of which operation are highly interesting and significant.[40] Here is a very thick and opaque species, *Biloculina bulloides*. The application of the X-rays reveals the internal arrangement of the chambers clearly. Here again is the coarse tropical calcareous form *Operculina complanata*, the whole of the interior septation of which is perfectly shown by the skiagraph. The process is especially valuable in connection with the arenaceous forms. Here is one of the most rugose species, and one which is exceedingly difficult to sectionise, owing to the sand-grains imbedded in the calcareous cement of which it is formed, *Cyclammina cancellata*. The skiagraph not only reveals its intricate labyrinthic interior, but here, as in the other species, reveals the fact that the individual is of the megalospheric stage of the life-cycle. The method is invaluable for the determination of doubtful species. The two species, *Jaculella obtusa* and *Botellina labyrinthica*, are externally very difficult to distinguish, but the skiagraph reveals the simple tubular cavity of the former as contrasted with the labyrinthic interior of the latter, and so determines the identity of the organisms.

You may rightly ask yourselves in what, beyond the beauty of the shells, consists the interest and value of the elaborate and concentrated study to which the Foraminifera have been subjected. Their value is both scientific and economic. They are the largest of the unicellular organisms—which are the closest to the beginnings of life—and if ever the structure and nature of protoplasm are to be determined, it will be, in my opinion, by the study of the Foraminifera that this conclusion will be arrived at. Economically they form the food of worms, starfishes, and many of the lower invertebrata, which in turn feed the food-fishes of the world.

I come now to the concluding and most important section of my discourse, which concerns itself with the phenomena of purpose and intelligence which I have

[37] J. J. Lister, "Contributions to the Life-History of the Foraminifera," Phil. Trans. Roy. Soc. (Lond.), vol. clxxxvi. B, pp. 401–453. 1895.

[38] F. Schaudinn, "Die Fortpflanzung der Foraminiferen," Wiegmann's Archiv. für Naturgeschichte, Jahrg. xlix., pp. 428–454

[39] F. Winter, "Zur Kenntniss der Thalamophoren," Archiv für Protistenkunde, vol. vii. 1907.

[40] J. E. Barnard, "X-Rays in Relation to Microscopy." Journ. R. Micr. Soc., p. 1. London, 1915.

claimed to be exhibited by some of the Foraminifera in the construction of their shells, a claim which has been, and is, denied by several very distinguished zoologists, and admitted, with some reservations, by others no less distinguished.[41] There are limits to what is known, but I refuse to admit that there are limits to what is knowable. As Prof. MacBride has justly observed: "To put forward an unknown entity as the cause of phenomena which we cannot unravel is not to explain, but in reality to give up the attempt at explanation."[42]

The method in which the arenaceous Foraminifera collect and adjust the materials from which they build their marvellous shells is obscure, and though a light begins to dawn upon the process it would take too long to go into the matter on this occasion. Surface tension no doubt plays an important part in the operation, but surface tension will not account for the mysterious fact that certain species, such as, to take a single instance especially, *Haplophragmium agglutinans*, incorporate into their shells fragments of heavy gem minerals such as magnetite, garnet, and topaz, which are not by reason of their specific gravity to be found in the same sand-strata as the relatively light quartz-grains which are mainly used in the construction of the shell. The common *Verneuilina polystropha* of our shores exhibits this phenomenon also to a remarkable degree. It is, however, the intelligence (and I use this word with a full sense of the responsibility which I incur in using it) displayed in the manipulation of the material which compels the attention of the biologist. We are all familiar with the beautifully built tubes of the Caddis worm, and some of the marine worms build tubes of no less remarkable ingenuity, as, for instance, Amphictene, and one local variety of this worm constructs its tube as neatly as a bricklayer building a wall out of fragments of sponge-spicules of a carefully selected size. But these are Metazoa, higher animals, endowed with organs and senses. The Foraminifera, I must repeat for emphasis, are unicellular creatures without any differentiated organs or even structure of any kind whatever.

Take the common arenaceous form, *Psammosphaera fusca*, which builds itself into a roughly agglutinated house of sand grains. There is no selection here. There is none in the variety *P. testacea*, which uses only the shells of dead and living Foraminifera—it uses them because it has nothing else to use; but *P. parva* (Fig. 6), finding itself by its small size and free habit liable to suffocation in the ooze on which it lives, builds its house round a catamaran spar formed of a long sponge-spicule, which buoys it up upon the mud surface. Another species, *P. rustica*, builds in the spaces of a tent-pole arrangement of such spicules —several individuals frequently combining to form a mutually supporting mass. This creature fills in the triangular spaces between the main tent-poles with broken spicules of successively graduated lengths, and when it arrives at an awkward terminal space finds and incorporates a truncated triaxial sponge-spicule to fill in the angle.

It is when we come to the devices employed by the Foraminifera for their protection from living foes, or the forces of nature, that their purposive intelligence becomes the most phenomenal. Many of the larger and doubtless more succulent forms are peculiarly liable to attack from parasitic worms—an elaborate study of which has been made by Prof. Rhumbler.[43] A striking instance of this occurs in the case of *Crithionina pisum*, which has a softly agglutinated shell, which is often found (as in one of the specimens exhibited) bored by worms. Certain individuals have arrived at protecting themselves with a *chevaux de frise* of sponge-spicules, and these we never find, so far as our experience goes, suffering from these attacks. *Haliphysema ramulosa* is another easily attacked species, and it protects its aperture with a similar defensive apparatus. The same protective investment is assumed by *Hyperammina ramosa*, a species which ramifies in a most remarkable manner, so much so that Earland once constructed for me a Christmas greeting slide out of its many vagariant forms. (The "selection" in this case is rather that of Earland than of the Rhizopod.)

The genus Marsipella, of which the most familiar form is *M. cylindrica*, is built up of sponge-spicules set parallel to its axis, and is excessively friable, perfect specimens being very seldom found. It consists of a simple tube affording an easy prey to parasitic worms. It has consequently learnt to protect itself with a crown of spines, which keep out these intruders. But some individuals, to which we have given the specific name *M. spiralis*, have made the same discovery as did the prehistoric genius who invented string. They increase their power of resistance to shock by twisting their spicules into a left-handed spiral, by which means their power of resistance is enormously increased.[44]

But probably the zenith of purpose and intelligence is reached by the genus Technitella, a genus named by

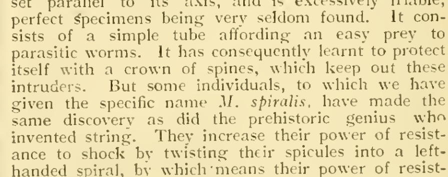


FIG. 6.—*Psammosphaera parva*, Flint.

Canon Norman—the Little Workman—with good cause. The most familiar species, *T. legumen*, builds its shell apparently of sponge-spicules set parallel to its axis. The accidental smashing of a specimen, however, revealed to us the fact that only the outer layer of spicules is thus disposed. The inner layer is set at right angles to the outer, thus producing the nearest approach to the woof and warp of a textile fabric possible in so rigid a material as sponge-spicules. This is clearly seen in a highly magnified fragment of a broken shell. The genus reaches its highest development of purposive selection, however, in our species *T. thompsoni*, which, out of the vast and heterogeneous mass of material at its disposition, selects only the anchor-plates of a particular kind of Echinoderm, which it cements together at their edges with an invisible cement, and thus constructs what is certainly one of the most decorative, and certainly the most highly perforated shell in existence.[45]

In the presence of the phenomena which I have exhibited before you this evening there are zoologists who aver that there is no such thing as purpose or intelligence to be postulated as a motive for the behaviour, not only of the Protozoa, but even of much higher orders of animal life. Jules Fabre, who has by consent assumed the purple among the historio-

41 E. Heron-Allen, "On Purpose and Intelligence in the Foraminifera," Proc. Zool. Soc., p. 1069. London, 1914.
42 E. W. MacBride, in NATURE, vol. xciv, p. 304. November 19, 1914.
43 L. Rhumbler, "Beiträge zur Kenntniss der Rhizopoden," Zeitschr. Wiss. Zool., vol. lvii., p. 589. 1894.
44 E. Heron-Allen and A. Earland, "On some New Astrorhizidæ and their Shell Structure," Journ. R. Micr. Soc., p. 382. 1912.
45 E. Heron-Allen and A. Earland, "On a New Species of Technitella from the North Sea," Journ. Quekett Micr. Club, ser. 2, vol. x., p. 403. 1909.

graphers of the insect world, denies intelligence even to the Digger Wasps, and to the Termites of Ceylon—at the end of all his amazing observations he says, "*Ils ne savent rien de rien.*" I prefer to go back exactly half a century to when Philip Henry Gosse, F.R.S., than whom no keener observer of marine organisms ever lived, said, "The more I study the lower animals, the more firmly am I persuaded of the existence in them of psychical faculties, such as consciousness, intelligence, and choice, and *that* even in those forms in which as yet no nervous centres have been detected."[46] A distinguished critic, Dr. Chalmers Mitchell, tells me that I might as well claim intelligence and purpose for such plants as the Tragopogons, the seeds of which are fitted with a parachute, which enables them to travel to new pastures. I almost wonder that I am not accused of agreement with the whimsical suggestion of Samuel Butler, who looked forward to the day when we should see little engines playing about the doors of the engine sheds, whilst the parent engine smoked peacefully inside. I refuse to admit that the seed parallel has any bearing upon the case. I am dealing with the utilisation of independent materials collected by the Foraminifera for a specific purpose. In the case of the seeds it is a development of a useful integral part and a consequent "survival of the fittest"—but if a bean in the kitchen-garden were to attach to itself the parachute of a Tragopogon and fly over the wall when in danger of its life at the hands of the cook, *that* would be an exercise of purpose and intelligence comparable with the phenomena which I have exhibited this evening.

An evolutionary cycle is *ex-hypothesi* continuous, and I refuse to allow a consistent evolutionist to postulate a discontinuity in his evolutionary cycle—he cannot at some unknown point introduce into his bioplasm an outside and novel influence to which he gives the name of "Intelligence." I claim that every living organism living an independent existence of its own is endowed with the measure of *intelligence* requisite to its individual needs.

We must accumulate facts, we must assimilate phenomena, we must strive after a comprehension of motive forces. To quote Prof. MacBride once more: "The use of hypotheses which assist in binding together the facts observed in the behaviour of living things, and in elucidating the laws which govern them . . . may be regarded as neither vitalistic nor mechanistic, but as plain common-sense applications of the indicative method. In this way only it seems to me we shall ever make progress with 'explanations' of the phenomena of life, for all 'explanation' in the last resort consists merely in putting together similar things."[47]

But to arrive at a conclusion we must study the life-history of these lowly organisms, which, as Prof. Verworn has said, seem to be especially provided for the biologists, since of all living creatures they are nearest to the origin of life. We must not merely collect and classify them like postage stamps. The study of the Foraminifera has been grievously afflicted with a tendency to lie upon a platform between two points, on one of which sits the invalided Man of Science who, forbidden by his doctor to work, has bought a pound of the comfit known to our youthful taste as "Hundreds and thousands," and who employs his time sorting out the red, the white, and the blue, setting aside as new species those globules which have been damaged in the process of manufacture—and on the other of which sits the Grammarian, whose sole regret upon his deathbed was that he had not devoted the whole of his life to the dative case.

46 P. H. Gosse, "A Year at the Shore," p. 247. London, 1865.
47 E. W. MacBride, in NATURE, vol. xciv., p. 304, November 19, 1914.

GEOGRAPHY OF BRITISH FISHERIES.

IN a paper entitled "Geography of British Fisheries," published in the *Geographical Journal* for June, Prof. J. Stanley Gardiner discusses the deep-sea fishing industry, trawling, and drifting, which has an annual value of upwards of fifteen million pounds. The main points of the paper are here summarised.

There are about 3000 first-class fishing vessels, of which the trawlers work from the White Sea to the Moroccan coast, wherever depths of fewer than 200 fathoms are found. Off Spain, Portugal, and Morocco their existence depends on the limit of territorial waters not being increased beyond three miles. What Prof. Gardiner is more especially concerned with are the habits of the fishes, their growth and reproduction, in so far as they are affected by the physical conditions of the waters in which they live. It is this correlation of habits with physical conditions that is essentially the geography of living animals. Not only have the adult fish to be considered, but also their eggs, their larval stages, and the eggs, young, and adults of all the lower animals and plants on which they feed.

FIG. 1.—Aberdeen Fish Wharf.

Currents merit particular attention, for the eggs and (or) young of practically all our food fishes are passively distributed by their agencies. Currents are best ascertained by regular observations on the temperature and salinity of the fishing waters, which are divided into oceanic and coastal zones, the former with relatively uniform conditions, the latter subject to great seasonal changes. A further division is into Atlantic and Arctic regions, our edible fish all belonging to the former, and following its waters in the summer as they push back the Arctic ice. There is, however, considered to be an intermingling of boreal and "Mediterranean" forms, once separated by a land ridge from Scotland to Iceland.

All fish ultimately depend on plant-life for their food. In the ocean floating plants are all-important, minute unicellular organisms living in incredible numbers in the upper layers of the water, in suitable conditions daily multiplying themselves, giving a fertility to the sea many times that of the best soil. The cycle of life of such pelagic plants in the open ocean is simple, complicated only by fluctuations in sunshine, rainfall, and other meteorological conditions. In coastal waters, especially where broad shelves extend out from the land, such fluctuations are more considerable, and often enormous seasonal changes in temperature and salinity have to be added. Instead of the same species of plants all the year round, and in consequence of the smaller animals which feed upon them, there may be a whole series of species, each suitable to some particular phase of seasonal change. Form succeeds form, the old form disappearing, perhaps passing into resting stages upon the bottom, until suitable physical conditions bring them once more into active life. It seems possible that this very destruction and re-creation adds further to the total food of our seas. The peculiar richness of the fishing grounds is, however, mainly ascribed to the abundant land-drainage of western Europe with its teeming population, to this being due much of the nitrogen, phosphorus, and silica in forms available for living organisms.

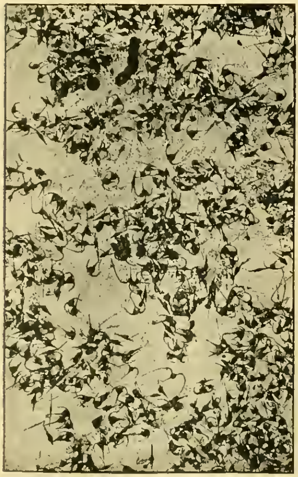


FIG. 2.—Floating plants, mainly Ceratium.

Most fish are bottom-feeders, and the ground must be suitable to the animals upon which they feed. Mud, the deposition of which implies the absence of movement, is inimical to all life. Flat fishes are themselves only suited to sand, on which they rest, invisible to their enemies. The cod and haddock prefer respectively rock and sand, but the hake, ling, coalfish, and whiting, belong to a family of such remarkable adaptability in feeding that it is of vast economic importance. The herring deposits its spawn on rocky ground, so that its eggs get well aerated and are not silted over, but most other economic fishes have floating eggs.

As examples the plaice, cod, herring, mackerel, and eel are chosen. Each has its own spawning grounds, its optimal depth, salinity, and temperature at each period of its life, its own wanderings in search of food, etc., and its own peculiar development. The plaice has its southern limit at the isotherm 10° C. The North Sea stock spawns in February, principally off our coasts between Dover and Cromer, and the eggs and young require to be carried by the currents so that the latest larval stages fall on the bottom in not too great intensity in a few feet of water, which must have a salinity of at least 0·017. Naturally the Dutch coast is the great plaice nursery, and from here the young fish gradually disperse into deeper and deeper waters, at the same time becoming more suitable to the food they produce, until in their fourth season they undertake their first breeding migration. The eggs, which are somewhat corrugated, have been found carried into the Baltic in undercurrents of warmer Atlantic water, a phenomenon considered to be correlated mainly with viscosity. Growth is a matter largely of temperature and salinity. Thus in the North Sea a fish of 40 cm. long is six years old, as shown by its otoliths, and in Barents Sea (White Sea) about eighteen. The latter rate of growth is found in the brackish Baltic, where 40 cm. and eighteen years are about the limits as contrasted with 70 cm. and fifty years in Barents Sea.

The herring is a feeder on the floating life of the sea, and rises and falls in the water by night and day, shunning the light. It exhibits somewhat similar rates of growth to the plaice as shown by its scales, which form broad, transparent growth-bands in summer as contrasted with narrow, opaque bands in winter, the fish not shedding its scales during its life. By the study of the breadths of the summer bands the areas where fish spent their previous lives may be ascertained, and thus breeding shoals may be analysed. Maturity is reached in different localities in from three to ten years. The spawn is laid on the bottom and at 3° C. hatches in forty days, at 12° C. in eight days. The young are at the mercy of the currents, and good years off Norway are considered to be those in which spawning is late, the currents being more determined and the sea having abundance of minute and suitable plant-life as food.

Prof. Gardiner concludes with a plea for the continuation after the war of the International Council for the Exploration of the Sea, which came into existence in 1902. Any control of the West European fisheries must be by international agreement, for which, as he says, there must be a foundation of incontestable evidence. The conferences of the representatives of the twelve countries on the International Council have been highly profitable in the investigations of the economic conditions of fisheries, depend-

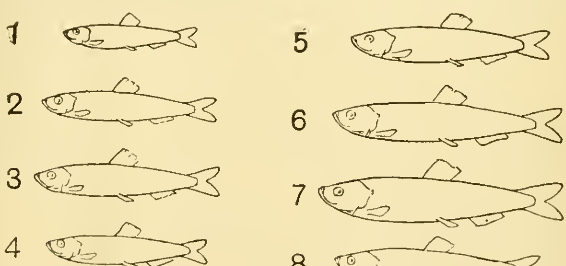


FIG. 3.—Rates of Growth of Herring. Eight fish of equal age (four years) from: 1. White Sea; 2, Lysefjord, Norway; 3, Zuyder Zee; 4. East Coast of Sweden; 5, West Part of North Sea; 6, Atlantic Ocean; 7, Iceland; 8, West Coast of Norway (Spring Herring). (*After Hjort*).

ing as these do on immense and fundamental scientific problems. Any fishery agreement is useless unless all neighbouring countries are signatories, and the matter is one of the food of a vast number of the human race. Furthermore, in the extension of such international institutions lies the best hope of permanent peace.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Prof. Albert C. Seward, professor of botany in the University, has been elected master of Downing College, in succession to the late Prof. Howard Marsh.

The Medical College of the University of Cincinnati received several large donations during July. We learn from *Science* that Mrs. Mary M. Emery promised the University the sum of 50,000*l.* for a new medical college building, on the condition that an additional 50,000*l.* be raised by July 1 for its equipment and maintenance. At the appointed time, Dean C. R. Holmes, of the College of Medicine, announced that the 50,000*l.* had been secured. The sum of 6000*l.* has just been raised by citizens of Cincinnati for the purpose of maintaining for three years a chair of medicine in the Medical College. The chair will be known as the Frederick Forchheimer chair of medicine, in honour of the late Dr. Frederick Forchheimer, who was for years professor of medicine at the Medical College.

The new metallurgical buildings at the University College of South Wales and Monmouthshire, Cardiff, were formally opened on Monday, July 26, by Sir Clifford J. Cory, Bart., M.P. The building which has been erected forms an important addition to the present department of metallurgy, and provides accommodation for assaying, analysis of fuels, metallography, and photomicrographic work, lecture theatre, professors' private room, balance- and reading-rooms, etc. The laboratories are of considerable size, lofty, well lighted and ventilated, and contain the most modern and up-to-date equipment for teaching these branches of metallurgy. The erection of this new building is due to the generosity of the South Wales and Monmouthshire Coalowners' Association, in acknowledging which, Prof. Read directed attention to the fact that to enable the college to help, as it should, the industrial progress of the works in the district, provision would have to be made in the near future for putting down experimental furnaces for smelting and other operations, so as to be able to provide a thorough practical training for metallurgical students.

The Department of Technology of the City and Guilds of London Institute has issued through Mr. John Murray, Albemarle Street, London, W., at the price of ninepence net, its programme for the session 1915–16. The programme contains the regulations for the registration, conduct, and inspection of classes, the examination of candidates in technological subjects, and the award of teachers' certificates in manual training and domestic subjects. We notice that the syllabuses in both coal-tar distillation and intermediate products and in electro-metallurgy have been revised, that in boot and shoe manufacture has been redrafted, and the revised syllabus in mechanical engineering issued separately last session is now included in the programme. The conditions governing the award of full technological certificates in painters' and decorators' work, cabinet-making, bookbinding, and embroidery have been modified, and the lists of works of reference have been revised. The department now examines in more than eighty separate branches of technology, and the constitution of the examinations board, the representative character of the panel of consultative examiners, and the large number of practical men among the acting examiners, all provide convincing evidence of the pains taken by the executive committee to ensure that thoroughly practical teaching, based consistently upon sound scientific knowledge, shall be given in the technical institutions throughout the country.

The Board of Education has issued its Regulations for Technical Schools, etc., in England and Wales for the session 1915–16. They are not, except for minor matters, materially different from those of last year. The arrangement as to the payment of a fixed, or inclusive (as it is now termed), annual grant in respect of any efficient school occupying a definite educational place in the area and providing approved courses of instruction covering five or more years, is now extended to apply to senior or advanced courses, and the Board will also under certain conditions pay an inclusive grant to a local authority in respect of all courses carried on under its direction for the year 1915–16, and grants may be paid for the year 1914–15 calculated upon the same basis. Examinations upon the courses of study must be held by the teachers in each year, and in the final year an external assessor must be associated with the teachers, but other arrangements may be approved for students taking senior part-time courses. Certain new conditions are attached to the endorsement of certificates. The onerous condition still remains in the regulations for junior technical schools whereby the pupil must enter upon the employment for which the school provides, thus debarring a clever pupil from entering upon the advanced courses of a higher technical school, and recognition will be refused to a school unless the pupils so enter. Classes in university tutorial courses may be duplicated so as to enable artisan students to attend the one or the other, and arrangements will be approved for special advanced courses of instruction, where adequate provision exists for tutorial classes of the ordinary standard, for students who have passed through the three years' course satisfactorily. The exigencies of the war have caused the Board to sanction short courses suitable for recruits, and for housewives in economical cookery.

In October next the *Athenaeum* proposes to start a subject index to periodicals as a regular monthly issue. The index is to embrace bibliography, theology, philosophy, sociology, geography, history, the fine arts, *belles-lettres,* and the science of everyday life. Pure science, law, and medicine will not be included. A preliminary notice of the scheme appeared in the issue of our contemporary for July 3, and specimens of the proposed lists have been given in succeeding issues in the form of an index to publications relating to science and technology, with special reference to the war. A very large number of cross-references make it easy to find one's way about the index already published. The *Athenaeum* proposes to index more than two hundred periodicals—English, American, and Continental—with occasional selections from a much wider field. We imagine it will be found extremely difficult to decide which periodicals are to be favoured by inclusion among the two hundred. The short specimen index published already contains references to more than sixty periodicals. The International Catalogue of Scientific Literature, which has been indexing the literature of science for the past ten or twelve years, indexes not fewer than 8000 periodicals. So long as authors continue to publish important papers in little-known periodicals, it will be impossible to produce a complete index without taking the less important journals into consideration. If all who are engaged in preparing general subject-indexes were to agree as to which periodicals should be indexed, and were to publish beforehand the names of the periodicals they proposed to index, it is possible that such action might have influence upon authors who have not yet decided where they should publish. Unfortunately the periodicals excluded from the list will immediately show cause why they should be included. We have no doubt that the *Athenaeum* will find a way of dealing with this difficulty, and we wish our contemporary success in its new undertaking.

SOCIETIES AND ACADEMIES.

Edinburgh.

Royal Society, June 28.—Dr. Peach, F.R.S., vice-president, in the chair.—Prof. J. W. **Gregory**: Contributions to the geology of Benguella and some Cretaceous Echinoidea from the north of Lobito Bay.—G. W. **Tyrrell**: Notes on rocks obtained in Angola by Prof. Gregory.—R. B. **Newton**: Some Cretaceous shells from Angola.—G. C. **Crick**: Some Cephalopoda from Benguella.—Mrs. Margaret F. **Romanes**: Notes on an Algal Limestone from Angola. These six connected papers were based on the visit in 1912 of Prof. Gregory to Angola and Benguella, Portuguese West Africa, and on the material collected and brought home by him. The earliest explorers of this region were Livingstone, who described the chief features of the physiography, and Cameron, who discovered Cretaceous rocks as well as widespread distributions of granite and gneiss. The Cretaceous rocks begin on the coast and end inland in great conglomerates at the floor of the old plateau of gneiss. The following conditions were recognised and described: Bihé Sandstones consisting of soft beds giving rise to the wastes known as the "hungry country"; Oendolongo sandstones, rhyolites, and tuffs, often like the Old Red Sandstone, referred by some to the Devonian, by others to the Torridonian; Lepi greywackes with cherts, tuffs, and slates; Huambo Quartzites, pre-Torridonian. The coast is traversed by numerous step faults, cutting through the Cretaceous rocks. The fossils of these rocks are described by R. B. Newton. A number of the species are new to the area.—W. F. P. **M'Lintock**: The zeolites and associated minerals from the tertiary lavas around Ben More, Mull. The peculiar facies of vesicle-minerals in a belt of lavas traceable from areas free from contact metamorphism up to the margin of one of the big acid intrusions is described. The non-metamorphosed rocks are albitised olivine basalts, in which the olivine is completely, and the augite partially, chloritised. The vesicles are filled with chlorite, albite, epidote, prehuite, and scolecite deposited in the order named. Frequently these minerals are seated upon a coarsely crystalline layer of albite, augite, magnetite, and chlorite, with which the vesicle is lined, and it is concluded that the cavities were filled during the cooling of the lava. By contact metamorphism the contents of the amygdales of the lavas around the margins of the intrusion have been altered; the chlorite has gone to hornblende, the scolecite to prehnite, epidote, and ultimately to garnet; the prehnite, to epidote and garnet; whilst the epidote is replaced by garnet and aphene. The effect of the metamorphism has been generally to build up the minerals in the reverse order to that in which they were originally deposited in the vesicles.—R. C. **Mossman**: A see-saw of atmospheric pressure, temperature, and wind velocity between the Weddell and Ross Seas. By a comparison of the departures from the normal for each of these data during the years 1902–4, 1910–12 evidence was obtained of an opposite phase relationship or see-saw of meteorological conditions over these seas. The discussion formed part of a much wider inquiry into the meteorology of antarctic regions.—W. J. **Walker**: The magnetic quality of iron and steel as affected by transverse pressure. The compressing force acted perpendicular to the direction of magnetisation. The induction was measured ballistically. The general result was diminution of susceptibility with increase of transverse pressure; but there were variations from this general result which demanded further investigation.—W. **Hill**: Chalk boulders from Aberdeen and fragments from the sea-floor off the Scottish coast; and notes on the structure of the chalk occurring in the west of Scotland. These important papers were found among the author's possessions after his death.—Prof. E. **Topsent**: Supplementary paper on the sponges collected by the Scotia Scottish National Antarctic Expedition.—Dr. R. **Kidston**: The fossil plants of the Forest of Wyre and Titterston Clee Hills coalfields. With remarks on the geology of the coalfields by T. C. Cantrill and E. Dixon.

Paris.

Academy of Sciences, July 26.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The unpublished correspondence of the astronomer, J. N. Delisle.—J. **Boussinesq**: The importance of the rudimentary dynamics of Aristotle in the progress of Mediterranean civilisation.—C. **Gutton**: An induction balance designed for the detection of buried shells in ground under cultivation. Owing to the danger to agriculturists due to the presence of unexploded shells buried in the soil and the liability of explosion owing to contact with a plough, the author has devised a modification of the Hughes induction balance by means of which two persons can thoroughly explore a hectare of land in about three hours.—J. **Maldiney**: The retarding action of sugar in the development of photographic negatives and the permeability of gelatine to the metolhydroquinone developer, used alone or with sugar. A plate giving a complete image in five seconds under the influence of the developer alone can be retarded by the addition of sugar, the addition of 60 grams of sugar per 100 c.c. of developer causing a retardation of from three to five minutes. The action appears to be due to physical causes, the increased viscosity of the solution rendering the penetration of the gelatine emulsion slower.

Washington, D.C.

National Academy of Sciences, July 15 (Proceedings No. 7, vol. i.).—W. S. **Adams** and F. G. **Pease**: Nova Geminorum No. 2 as a Wolf-Rayet star. A continuous series of observations on Nova Geminorum No. 2 has shown the development of the spectrum of this star through the successive stages characteristic of novæ into one very strongly resembling that of planetary nebulæ; and then, by the gradual elimination of the nebular lines and their replacement by Wolf-Rayet bands, into a spectrum identical with this characteristic type of stellar spectra.—A. A. **Michelson**: The ruling and performance of a 10-in. diffraction grating. A 10-in. grating (actual ruled surface 9·4 in. by 28 in.) having a theoretical resolving power of about 660,000, shows an actual power of about 600,000. The methods of obtaining exact ruling is also discussed.—E. E. **Barnard**: A singular dark marking on the sky. From a dark object in Cepheus and those in Taurus the author gets the impression that the interstellar spaces are suffused with a feeble nebulosity and that the dark marks are due to the projection upon this background of nearer dark, opaque objects. —A. L. **Parson**: A highly sensitive electrometer. The principle of working in a condition approaching instability is used to increase greatly the sensitiveness of electrometer, and obtain an instrument theoretically sensitive enough to detect 10^{-6} volts (though unsteadiness makes it as yet impossible to detect an isolated potential-difference of less than 3×10^{-5} volts).—C. **Wissler**: The distribution and functions of tribal societies among the plains Indians: a preliminary report. Field-work conducted by the writer and his associates in the American Museum of Natural History leads to the conclusion that the societies have spread from tribe to tribe by culture diffusion of a desultory kind; that certain features of organisation are traceable to particular tribes, and no one tribe can be the originator of the society system as a whole.—T. W. **Richards** and L. B. **Coombs**: The determination of surface tension. Attention is directed to various sources of error in the measurement and in the calculation of surface tension by the capillary-tube method, an improved form of this method is described, a new correction for the meniscus is proposed, and exact measurements with a number of liquids are presented.—Ales **Hrdlička**: An exhibit in physical anthropology. The exhibits prepared under the direction of the author for the Exposition at San Diego are described briefly to indicate their breadth, their permanent value, and their capability of forming the foundation of an anthropological centre.—T. W. **Richards**: The compressibilities of the elements and their relations to other properties. This paper records all the recent work on the compressibility of the elements performed at Harvard, reduced to the best available standard—the newly-determined compressibility of mercury. It is pointed out that the reciprocals of the melting points are very closely associated with the coefficients of expansion, and that both these properties seem to be essentially connected with atomic volume and compressibility.—E. B. **Frost**: Radial velocities within the great nebula of Orion. We must alter our conceptions of the nebula as an enormous mass of quiescent gas, and regard it as seething with local whirlpools, besides perhaps having a considerable motion of rotation as a whole.—W. S. **Adams**: The radial velocities of the more distant stars. The radial velocity of stars increases rapidly with the proper motion, and only very gradually with the spectral type. This agrees with Eddington's hypothesis that the relation between velocity and spectral type may be a relation between velocity and distance.—T. H. **Morgan**: Localisation of the hereditary material in the germ-cells. The chromosomes not only furnish a mechanistic explanation of Mendelian heredity, but in the case of non-disjunction and in the case of the point by point correspondence between the linkage groups and the chromosomes, furnish a verifiable explanation of the results. In the case of crossing-over and of interference the chromosomes give us the only objective explanation of the results that has been as yet offered.—G. P. **Merrill**: Researches on the chemical and mineralogical composition of meteorites. Abstract of extensive investigations which will appear as a memoir in the series of Memoirs of the National Academy.—W. B. **Ford**: The representation of arbitrary functions by definite integrals. The function $f(x)$ is represented as the limit of a definite integral depending on a parameter when the parameter becomes infinite, or by a series of definite integrals.—J. B. **Murphy** and J. J. **Morton**: The lymphocyte as a factor in natural and induced resistance to transplanted cancer. A marked increase in the circulating lymphocytes occurs after cancer inoculation in mice with either a natural or induced immunity. When this lymphoid reaction is prevented by a previous destruction of the lymphoid tissue with X-ray the immune states are destroyed; hence the lymphocyte is a necessary factor in cancer immunity.—W. D. **MacMillan**: Some theorems connected with irrational numbers. The presence of the factors $i - j\gamma$ in the denominators of series rising in celestial mechanics does not affect the domain of convergence of the series, provided γ is a positive irrational number which satisfies a rather mild condition.

BOOKS RECEIVED.

Descriptive Geometry. By H. W. Miller. Third edition. Pp. 149. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s.* 6*d.* net.

Fighting the Fly Peril. By C. F. Plowman and W. F. Dearden. Pp. 127. (London: T. Fisher Unwin, Ltd.) 1*s.* net.

Fungoid Diseases of Farm and Garden Crops. By Dr. T. Milburn. Pp. xi+118. (London: Longmans and Co.) 2*s.* net.

Alcoholometric Tables. By Sir E. Thorpe. Pp. xiv+91. (London: Longmans and Co.) 3*s.* 6*d.* net.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. ii., No. 5. Nemertinea. By H. A. Baylis. Pp. 113–134+2 plates. (London: Longmans and Co., and others.) 2*s.* 6*d.*

Catalogue of the Mesozoic Plants in the British Museum (Natural History). Part vi. The Cretaceous Flora. Part ii. Lower Greensand (Aptian) Plants of Britain. By Dr. Marie C. Stopes. Pp. xxxvi+360+xxxii plates. (London: Longmans and Co., and others.) 21*s.*

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THURSDAY, AUGUST 12, 1915.

THE PROBLEMS OF SCIENCE.

Problems of Science. By Prof. F. Enriques. Authorised Translation by K. Royce. Pp. xvi + 392. (Chicago and London: The Open Court Publishing Co., 1914.) Price 10*s.* net.

BESIDES two introductory chapters of a more or less metaphysical kind, this work contains four others dealing respectively with logic, geometry, mechanics, and the extension of mechanics; the last concluding with a section on the phenomena of life. This range of subjects is so great that, as might be expected, the treatment of them is unequal; but the fact that they are all discussed by a mathematician is significant, and for at least two of the main topics (geometry and physics) the author's special knowledge is of great value.

Naturally, a reader will be inclined to attach most weight to the section on geometry; in some respects he will be right. In this domain Prof. Enriques is a leading authority, and as he is treating of a subject with which he is thoroughly familiar, the result is very lucid and informing. We have a valuable historical account of the development of geometrical concepts, culminating with projective geometry in its modern form, and the different non-Euclidean theories, including the non-Archimedean geometry of Veronese; a good discussion of postulates; and a certain amount of psychological criticism, which is of a more controversial kind. One remark may be noticed as being (in English, at any rate) rather misleading. Before discussing Veronese's geometry, the author says:—"In the preceding examples the postulates that correspond to the various geometries express different physical hypotheses." As it stands, this is incorrect; any geometry, *as such,* is independent of physics altogether. What is probably meant is that each of the three Archimedean geometries is conceivably admissible as the "real" geometry most suitable for the physicist to assume in constructing his hypotheses. For instance, certain observations might make it simpler to assume a Riemann geometry than to modify the laws of motion. There is, on the other hand, no possibility of detecting by observation the existence of a non-Archimedean space, and there does not seem to be any possible development of physics which would naturally require the assumption of such a space.

To us the most interesting part of the book is that which deals with time. The author makes (like Bergson) a distinction between psychological and physical time which is likely to be really valuable, if used with the proper reservations; and he makes several useful remarks which illustrate the difference between a mathematician and an unmathematical metaphysician. For instance, it is pointed out that "the notion of before and after does not furnish any criterion for comparing two intervals of time which have not a common beginning (or end)"—or, we may add, are derived from a succession A, B, C, D, which involves that $BC < AD$. For instance, yesterday and to-day together are longer than to-day; but from this we cannot infer anything about the length of to-day as compared with that of yesterday. The importance of having a clear concept of time has been recently emphasised by the theory of relativity (discussed pp. 349–63), and hypotheses in elasticity and thermodynamics where the influence of "heredity" is assumed (pp. 316–17).

The sections on physics are very interesting, and, so far as we can judge, give a sound and clear view of its main principles, as at present understood. The author's general attitude is stated on p. 366 in a passage too long to print here. Briefly, it is that in any physical science we form a set of concepts and hypotheses by abstraction from a set of experiments; we thus have a provisional "scheme of relations" which we test by more refined experiments. The latter may refute one or more of our hypotheses; as a matter of fact, the more usual result nowadays, at least in physics, is to suggest corrections or modifications in our formulæ, by which they become more concordant with the results of observation. This summary, of course, does not do justice to the author; it is in the way he shows historically how these tendencies have been at work that one great merit of his work consists. In this respect he may be compared with Mach, by whom he has evidently been much influenced.

The section on biology might well have been omitted; the time has not come for making any such general statements about the principles of biology as we can make about those of mathematics and physics. We are glad to find, however, that on p. 201 he does protest (all too mildly) against some of the absurdities of the experimental psychologists, when they wander from their proper sphere. That Wundt, for instance, should attempt "to derive the planary structure of intuitive space from the fact that the arrangement of the bones is such as to favour rectilinear movement" is one of the most extraordinary examples of begging the question we have ever seen. As Prof. Enriques points out, the arrangement of the bones is *not* in favour of

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rectilinear movement; but apart from this, the use of the word "rectilinear" here is a *petitio principii* of the grossest description. How can we say anything about the adaptation of the bones to rectilinear movement until we have the concept of what rectilinear motion is?

This leads us to the consideration of the more metaphysical parts of the book. Frankly, we disagree with the author on one or two fundamental points. He protests against the absolute as an illusion—even against what we may call the special absolute; we believe, on the other hand, with Bradley, that in a certain sense the absolute does "precede," or is involved by, the relative. At the same time, we may fully admit that concepts are formed by a psychological process, and that there is no *realisation* of an absolute, in the same sort of way that we cannot realise the arithmetical continuum as we can the numbers 2 and 3. Again, the author just touches on cases of illusion, insanity, and complete hallucinations; saying of the latter that "fortunately they seem quite rare." Doubtless this is fortunate, in one sense; but to ignore them without attempting to give a philosophical explanation of them is merely a confession of failure. However, we must agree to differ on metaphysics for the present, and be thankful that so much has been done recently to clear away fallacies and quibbles, and bring the real problems of philosophy into view.

The translation reads well on the whole, and we have only found one misprint of importance: on p. 321 "vertical" should be "vortical." On p. 17 the account of Russell's "vicious circle" analysis is not clear; whether this is the fault of the author or that of the translator we cannot say. What Russell has pointed out is that we are talking nonsense when we ascribe to a class of classes a defining quality which characterises its members: for instance, to speak of "the number of all numbers" is as nonsensical as to say "the animal comprising all animals." Similarly, there is no "class of all classes," and this is the most important example of the theorem. G. B. M.

PHYSICAL CHEMISTRY OF MOLECULES.

Molecular Association. By Dr. W. E. S. Turner. Pp. viii + 170. (London: Longmans, Green and Co., 1915.) Price 5*s.* net.

THE progress of chemical theory has been connected in an intimate way with the study of the complexity of molecules. By the introduction of Avogadro's hypothesis the determination of molecular complexity in gases was reduced to a comparatively simple problem. The development of the osmotic theory of solutions provided a theoretical basis for the interpretation of the results obtained in the investigation of the vapour pressures and freezing points of solutions. In so far as dilute solutions are concerned, the problem of molecular complexity is partially solved by the application of osmotic methods, although the question of the association of solute and solvent in the same molecule does not lend itself to attack in this way. When we pass from dilute to concentrated solutions or liquid mixtures, the problem acquires an entirely different character. For such mixtures there is no general guiding and reconciling principle such as is afforded by the hypothesis of Avogadro. The same difficulty confronts us when we deal with pure liquids. The methods available for the investigation of the molecular condition of pure liquid substances are entirely empirical, and the value to be attached to the various methods which have been proposed is at present largely a matter of personal opinion.

It is with the dependence of the complexity of the molecule on the nature of the constituent atoms, and on the forces which act on it, in so far as these forces are modified by changes in temperature, concentration, state of aggregation, and nature of the solvent, that the author's subject-matter is concerned. One chapter is devoted to the molecular complexity of gases, two to the complexity of dissolved substances, and three to that of pure liquids.

The molecular condition of pure liquids has attracted a great deal of attention in recent years, and the literature of the subject has attained to such dimensions that a summary and critical survey of the methods involved is particularly opportune. Molecular association has been the theme of the author's own work for many years, and it is therefore quite intelligible that the monograph is not a mere compilation of facts and hypotheses, but represents an extensive, well-ordered, and closely reasoned discussion of the salient features of the subject.

In an appendix, which runs to forty-four pages, the author gives a tabular record of the results of the investigation of the molecular complexity of dissolved substances. As a table of reference this should be found extremely useful, and its compilation adds materially to the value of the work.

Comprehensive as the monograph appears to be, there are certain noteworthy omissions. For instance, the reviewer has looked in vain for any reference to the determination of the molecular complexity of dissolved substances by means of the lowering of transition temperatures. Such investigations afford information relative to the molecular condition of substances in concentrated salt solutions. Although limited in their application, these measurements afford results of considerable interest, and according to the writer's experience the transition-point method is capable of the same degree of accuracy as the familiar method of freezing-point depression. Notwithstanding small deficiencies of this nature, the book must be ranked as a valuable contribution to the series of monographs on selected chapters of physical chemistry. H. M. D.

THE FUNDAMENTALS OF THREE-COLOUR PHOTOGRAPHY.

Three-Colour Photography: with Special Reference to Three-Colour Printing and Similar Processes. By Arthur Freiherrn von Hübl. Translated by H. O. Klein. Pp. 138. (London: Percy Lund, Humphries and Co., Ltd., 1915.) Price 7*s*. 6*d*.

THE scope of this volume is much more limited than the title might be supposed to indicate. The author deals with the theories of light and colour so far as concerns the subject, and in a thoroughly practical way with the sensitising of plates, the making and choice of colour filters, and the choice of inks, but the actual printing processes themselves are barely mentioned. Screen-plate processes, such as the use of autochrome and similar plates, are not dealt with. We have therefore a treatise on the fundamentals of three-colour photography. We must first express our disappointments. At page 95 there are eight absorption spectra, showing the effect of each dye in two concentrations, but we cannot find any indication as to the dyes to which these spectra refer. There are references to "Supplement IV.," a coloured plate which should contain some most interesting results, but the plate is not anywhere to be found. At page 80 we are told that "for accurate work it is necessary to measure the densities with the aid of Marten's polarisation photometer," as if this were the only instrument suitable for this purpose, or the only accurate photometer applicable. Of course, there are many forms of photometer available, and not everyone would prefer the Marten instrument.

Having said so much, we have nothing to express but a vivid appreciation of the value of the treatise. The formulæ given are not innumerable, but they are the select few chosen by one who is thoroughly conversant with the subject. It is interesting to note that the author is not one who struggles after theoretical perfection at any price, as some seem to do, perhaps because of their want of acquaintance with the practical side of the art. He says quite clearly that three-colour photography is based upon sound theoretical principles, and fully justified from a theoretical standpoint. But on the other hand, it is more or less immaterial whether or not the photographic colour analysis is absolutely correct, and that "fine-etching or retouching is the greatest factor in solving the problem of three-colour process work." One may be rather sorry to see so high an authority take up such a position, but he justifies his opinion with regard to inks, by pointing out that the theoretical inks are so "very bright and fiery," that the colour scheme is very sensitive, and therefore the slightest error in the balance of the pigments makes it impossible to produce neutral greys or black under ordinary printing conditions. The use of a pure yellow, an almost blackish blue, and a very deep red allows of slight variations in their proportional intensities without greatly influencing the result, and are to be preferred, although they reduce, to a certain extent, the range of colours that can be reproduced. Moreover, artists use blackish (not pure) colours, and the "colour magnificence of a painting is not due to the use of brilliant pigments, but to the effects of colour contrast." The pigments of modified colour have the further advantage of being less liable to change on exposure than those that more nearly approach the theoretical requirements. In spite of this apparent qualification of the indications of theory pure and simple, the theory is and remains sound, and it is only the uncertainties of practical work that require a little concession. C. J.

MEDICINES AND THEIR MANIPULATION.

(1) *The Extra Pharmacopœia of Martindale and Westcott.* Revised by Dr. W. H. Martindale and W. W. Westcott. Sixteenth Edition. Vol. i. Pp. xl + 1113. Price 14*s*. net. Vol. ii. Pp. viii + 469. Price 7*s*. net. (London: H. K. Lewis, 1915.)

(2) *Squire's Pocket Companion to the British Pharmacopœia.* By P. W. Squire. Second edition. (London: J. and A. Churchill, 1915.) Price 10*s*. 6*d*. net.

(1) THE first volume of Martindale and Westcott's Extra Pharmacopœia contains all matters relating to the chemical and therapeutic properties of those "extra-pharmacopœial" chemicals and drugs which have attracted particular attention in the medical world. It includes details of their manufacture and modes of administration, their medicinal uses, pharmacy and solubilities, and references to current literature. This volume also contains, *inter alia*, a chapter on vaccines, supplying much new information, the section on organo-therapy, the supplementary list of drugs, and a list of the most potent antiseptics based on researches by the authors. Volume ii. contains the latest methods of assaying and testing

chemicals and drugs, and those employed in clinical and bacteriological diagnosis and analysis. We find a full account of Abderhalden's serum reaction, of a bacteriological examination of distilled and drinking waters, with a table of the analytical results obtained, and the conclusions founded on them, of the various methods for performing the Wassermann reaction for syphilis, and of the chief advances made in bacteriological technique. This volume will be found invaluable in the chemical, bacteriological, and pharmaceutical laboratory. Martindale's Extra Pharmacopœia should find a place on the library shelf of every medical practitioner and pharmacist.

(2) In 1904, owing to the increasing size of "Squire's Companion," it was decided to subdivide the work, and to publish it in two parts, "Squire's Pocket Companion" and "Squire's Companion." "Squire's Pocket Companion" is the smaller volume, containing information on such matters as are commonly arising in the orinary course of prescribing and dispensing, and is written specially for the medical profession. This second edition of the work follows the lines of previous editions of the Companion, and is arranged in alphabetical order. The principal monographs are divided into distinctive headings, a description of the drug with its usual method of preparation, solubility, medicinal properties, dose, prescribing notes, incompatibles, official preparations, not official preparations, and antidotes.

The solubilities of chemical substances have been completely revised and the medicinal properties brought thoroughly up to date, the latest references being included. The doses are given in both the imperial and metric systems, and are those generally employed. The prescribing notes have received particular attention, and the revision has been very thorough and complete.

The chapter on therapeutic agents of microbial origin has been almost completely re-written by Prof. Hewlett; it gives full information on antitoxins, serums, tuberculins, vaccines, etc. A list of British and foreign spas is included, also a therapeutical classification of remedies, with a list of those applicable for special ailments. A full general index enhances the value of the work, which will be found of the greatest service by the medical practitioner and pharmacist.

MIND IN ANIMALS.

The Investigation of Mind in Animals. By E. M. Smith. Pp. xi+194. (Cambridge: At the University Press, 1915.) Price 3*s*. net.

THIS is a book intended for the general reader rather than for the investigator; and, considering its limited size, it is a very admirable presentation of the best methods by means of which the problem of the nature of animal conduct is now being investigated. This problem is primarily one for the naturalist who knows very intimately the habits of the organisms that are to be studied. Yet experimental psychology is now a science with well-developed methods and criteria, and with a technique of its own, and one cannot consider the multitude of instances of apparently intelligent behaviour in the lower animals without feeling that much of the lack of critical examination of these cases is due to imperfect knowledge of this technique. The student of biology will find the author's short accounts of the experimental methods devised by Jennings, Yerkes, Thorndike, and others very serviceable, and the bibliography contains references to most of the important memoirs.

The author avoids controversy and discussion as much as possible, and short statements of his own conclusions would have added to the value of the book. He relegates the theory of tropisms to a very subordinate place, refusing it that generality that has occasionally been claimed for it. Jennings's interpretation of the apparently random movements of certain protozoa as based upon a method of trial and error is accepted, but it is argued that rigid determinism is nevertheless involved, although plasticity of behaviour is implied in Jennings's interpretation. The conclusion is not very clear. The book contains a fair account of the admitted phenomena of "homing" among birds and insects. There is a short summary of the evidence in favour of ideation in animals other than man; and in the last chapter the reader will find too short a reference to the wonderful thinking horse which in ten seconds found the fourth root of the number 456976! J. J.

OUR BOOKSHELF.

The Principles of Rural Credits as Applied in Europe and as Suggested for America. By J. B. Morman. Pp. xviii+296. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 5*s*. 6*d*. net.

ALTHOUGH this book is written primarily with the idea of calling attention to the problems of credit as they affect farmers in the United States and Canada, it contains much of interest to any student of rural economics. The whole subject has been investigated recently by the United States Commission on Rural Credits, and the present volume is largely a condensed and popularised version of the Commission's reports to Congress. In this way the book falls naturally into two parts: the first consists of the information collected from an exhaustive study of the systems of rural credit in operation in Europe; in the second this information is used to suggest methods applicable to the special needs of American farmers. In 1913 the German farmer could borrow from his mutual credit association at $3\frac{1}{2}$ per cent., while his confrère in the Western States was paying from 6 to 10 per cent. for similar accommodation. The difference in the value of money in the two continents was, of course, partly responsible for this—a difference which the present enormous waste of capital in Europe will certainly reduce—but the advantages of the old-world farmer were chiefly due to his superior organisation.

For the provision of personal or short-time credit, the combination of farmers into co-operative credit societies is recommended. Seventeen States have already passed laws to facilitate the formation of such societies, but the scattered population on the large farms of the West renders the Raiffeisen type of credit bank, so successful in Europe, much more difficult to organise in America. As regards long-time loans to the landowning farmer, the State should grant these at reasonable rates of interest, and on the amortisation plan of repayment, by which equal payments over the period covered by the loan both meets the interest and extinguishes the capital debt. The author has set out a mass of facts and figures with great clearness, and has further provided a very complete bibliography of the subject.

The Statesman's Year Book. Edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. Fifty-second annual publication. Revised. Pp. lxxxiv + 1536. (London: Macmillan and Co., Ltd., 1915.) Price 10*s.* 6*d.* net.

The editors of the "Statesman's Year-Book," gravely incommoded as they have been by the effects of the war, have met the situation successfully. The statistics given for enemy countries and Belgium are for the most part of no more than historical interest, but they have been revised to the latest dates possible, and will be of value in the future for purposes of comparison. Special revision is stated to have been applied to the sections on Turkey, China, Greece, Spain, and the Panama Canal zone. The accounts of Chinese government and administration are very clear so far as they go, and the statistical tables for this country have been decidedly improved. To the introductory tables some pages have been added specifically dealing with the war. The dates of nineteen separate declarations of war between July 28, 1914, and May 23, 1915, are furnished. The list of principal events of the war might well have been fuller, but there is a useful catalogue of the principal official and unofficial war publications.

The coloured maps are all pertinent to the war —an ethnographical map of Central Europe, an historical map of Prussia, and a map illustrating the three partitions of Poland (1772, 1793, and 1795), which is not very easy to follow. A map of the "World Colonial Powers concerned in War" is merely a map of the dominions of all the great European colonising Powers, including the Dutch. Attention has clearly been paid to the bibliographies, many of which are substantially more valuable than formerly; perhaps the selection of works other than those quite recently published is still open in some instances to further revision.

Lessons and Experiments on Scientific Hygiene and Temperance for Elementary School Children. By Helen Coomber. Pp. xx + 163. (London: Macmillan and Co., Ltd., 1914.) Price 1*s.* net.

Many people have an idea that it is impossible to learn physiology without the complex paraphernalia of the modern laboratory. Some go to the other extreme, and imagine it is possible to become acquainted with the subject from books alone. Both are obviously wrong, and Miss Coomber's manual will show how easy it is to teach the principles of elementary hygiene (applied physiology) with quite simple materials, such as a few bottles, a spirit lamp, a chemical reagent or two, and material such as any butcher can furnish. Whilst thoroughly agreeing with the underlying idea of the book—that such teaching, to be effective, must be practical—one is a little doubtful whether the system of question and answer, which is adopted throughout, though most suggestive to the teacher, is really the best for the learner. Some little summary of the main conclusions in each section should follow (or precede) the catechism and practical exercises. Indeed, the authoress oftens feels this herself, for some of the answers are prodigiously lengthy. Experience will, however, show whether some short connected accounts will be advisable in future editions. Any competent teacher could quite well supply the want if it is found necessary, and perhaps Miss Coomber thinks that this is the duty of the actual teacher rather than that of the writer of the present admirable little guide.

W. D. H.

Making the Most of Life. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix + 298. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

This is another of the many elementary manuals on physiology and hygiene which are being so prolifically produced in the United States. It is written clearly and to the point, and without any undue use of technical terms. How to live healthily and long is the ambition of most of us; this makes all the more astonishing the colossal ignorance which prevails, even amongst otherwise well-educated people, of the most elementary rules of health. One cannot praise sufficiently a nation which seeks to make knowledge on such a vital question part of the education of every citizen. Useful lessons are drawn from the lives of such men as Gladstone, Tolstoi, Cornaro, and others; but the most important section of the book appears to us to be that devoted to the history of our microscopic foes, and the means to combat their attacks upon us. W. D. H.

LETTERS TO THE EDITOR.

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

The Principle of Similitude.

DR. RIABOUCHINSKY directs attention concisely in NATURE (July 29, p. 591) to an important point, which must have arrested the notice of readers of Lord Rayleigh's weighty exposition and illustration of the scope of the method of dimensions, as an instrument of precision in the analysis of physical problems. The example under consideration was the cooling of a hot wire by a stream of air passing across it. The point is that temperature, although in ultimate analysis it must be expressible in terms of the three fundamental dynamical entities—mass, space, and time—can yet be in that problem considered *effectively* as a fourth independent entity, thus vastly increasing the information derivable from comparison of dimensions. In the formal analysis of mere diffusion or conduction this is clearly valid, for the dynamical aspect of temperature is not involved.

In so far as thermodynamic considerations, such as work of expansion, etc., are of secondary importance in the analysis of the convection from a hot wire (as is the case so long as only an adhering surface layer of the gas need be taken as operative [1]), the same principle will apply approximately there. But in a problem the content of which is mainly thermodynamic, the relations will be far more complex. In fact there is nothing transcendental about dimensions; the ultimate principle is precisely expressible (in Newton's terminology) as one of *similitude*, exact or approximate, to be tested by the rule that mere change in the magnitudes of the ordered scheme of units of measurement that is employed must not affect sensibly the forms of the equations that are the adequate expression of the underlying relations of the problem.

J. L.

Cambridge, July 31.

THE question raised by Dr. Riabouchinsky (NATURE, July 29, p. 591) belongs rather to the logic than to the use of the principle of similitude, with which I was mainly concerned (NATURE, March 18, p. 66). It would be well worthy of further discussion. The conclusion that I gave follows on the basis of the usual Fourier equations for conduction of heat, in which heat and temperature are regarded as *sui generis*. It would indeed be a paradox if the further knowledge of the nature of heat afforded by molecular theory put us in a worse position than before in dealing with a particular problem. The solution would seem to be that the Fourier equations embody something as to the nature of heat and temperature which is ignored in the alternative argument of Dr. Riabouchinsky.

August 2. RAYLEIGH.

The Probable Error of the Amplitudes in a Fourier Series obtained from a Given Set of Observations.

To express a periodic variation by one or more terms of a Fourier series is such a common and convenient method that it is of importance to know the extent to which the constants are trustworthy. This is particularly the case when the quantity is subject to a large casual and therefore non-periodic variation as well.

[1] *Cf.* also L. V. King, on hot-wire anemometry, *Phil. Trans.*, A 214 (1914), p. 373.

Suppose there are n evenly spaced observations, $y_0, y_1, y_2, \ldots y_{n-1}$, then confining attention to one term only, y may be expressed by the relation $y = a \sin(x - \alpha)$. This may be written

$$y = p \sin x + q \sin\left(x + \frac{\pi}{2}\right)$$

and the amplitude a is given by $a = \sqrt{p^2 + q^2}$.

The standard error of a therefore depends on that of p and q. To obtain p we write—

$$p = y_0 \sin 0 + y_1 \sin\frac{2\pi}{n} + y_2 \sin\frac{4\pi}{n} + \ldots + y_{n-1} \sin\frac{n-1}{n}2\pi$$

whence, if σ is the standard error of the y's, it is easy to prove that $\sigma\sqrt{2}/\sqrt{n}$ is the standard error of the p or q. This is also the standard error for any higher order term depending on the n observations.

From the way in which p and q are obtained it is obvious they may be positive or negative; the sign depends, in fact, upon the origin chosen, and their mean value obtained from many samples would be zero. But even in the case of there being no period at all, and the y's being purely casual, it is very improbable that both p and q should be zero. In this special case the amplitude a is really zero, but it is almost certain, since it equals $\sqrt{p^2+q^2}$, not to be given as zero. Its mean square is plainly equal to twice the mean square of p or q, but this is not the square of the standard error, because it is not taken about the mean value.

To ascertain the general magnitude of the error the following plan has been adopted. From a sort of roulette board of 100 compartments, 500 pairs of numbers have been taken, the numbers on the board being arranged to have a standard deviation of 10, and a distribution as nearly normal as the limit of 100 numbers permits. From these pairs, representing the p and q of the sine curve, 500 amplitudes have been found. The result gives a mean amplitude of 12·5, a standard deviation of 6·5, and a distribution such that 4 per cent. exceed the value 25.

Similar results from 500 other pairs, but with a genuine sine curve of amplitude 10 superadded, give a mean amplitude of 16·5, a standard deviation of 8·0, and a distribution such that 8 per cent. are below 5, and 5 per cent. above 30.

From theoretical considerations it is apparent that as the periodic part of the variation becomes large compared with the casual part, the mean amplitude will still exceed, but will approximate to, the genuine amplitude, and the standard error will approximate towards that of p or q.

Suppose, then, that we have a set of n well-distributed observations, and that nothing is known about them in regard to their periodic variation. Let their standard deviation be σ. Now let the first three terms of the Fourier series be found in the usual way, and let the amplitudes be a_1, a_2, and a_3, the question that arises is, to what extent do a_1, a_2, and a_3 represent genuine periodic variations? The standard deviation σ may be due entirely to the periodic variations, or may be purely casual. In the former case it is easily proved that $\sigma = \sqrt{a_1^2 + a_2^2 + a_3^2}/\sqrt{2}$, and if this relationship is approximately satisfied, the larger amplitudes may be accepted as correct. But if the deviation σ of the observations is distinctly larger than that produced by the periodic part, the casual part of it will lead to error in the a_1, a_2, and a_3, and unless an amplitude when compared with $\sigma\sqrt{2}/\sqrt{n}$ is well outside the limits for the special values given above, it need not be significant.

It follows that the amplitude of any term in a sine curve deduced from only a moderate number of observations must be received with caution until an investigation of its probable error has been made, and this remark refers especially to the second and higher terms where the amplitudes are so often small.

W. H. Dines.

Benson Observatory, Wallingford, July 29.

ON THE CHARACTER OF THE "S" SOUND.

Some two years ago I asked for suggestions as to the formation of an artificial hiss, and I remarked that the best I had then been able to do was by blowing through a rubber tube nipped at about half an inch from the open end with a screw clamp, but that the sound so obtained was perhaps more like an *f* than an *s*. "There is reason to think that the ear, at any rate of elderly people, tires rapidly to a maintained hiss. The pitch is of the order of 10,000 per second."[1] The last remark was founded upon experiments already briefly described[2] under the head "Pitch of Sibilants."

Doubtless this may vary over a considerable range. In my experiments the method was that of nodes and loops (*Phil. Mag.*, vol. vii., p. 149 (1879); Scientific Papers, I., p. 406), executed with a sensitive flame and sliding reflector. A hiss given by Mr. Enock, which to me seemed very high and not over audible, gave a wave-length (λ) equal to 25 mm., with good agreement on repetition. A hiss which I gave was graver and less definite, corresponding to $\lambda=32$ mm. The frequency would be of the order of 10,000 per second, more than 5 octaves above middle C.

Among the replies, publicly or privately given, with which I was favoured, was one from Prof. E. B. Titchener, of Cornell University,[3] who wrote:—

Lord Rayleigh's sound more like an *f* than an *s* is due, according to Köhler's observations, to a slightly too high pitch. A Galton whistle, set for a tone of 8400 v.d., will give a pure *s*.

It was partly in connection with this that I remarked later[4] that I doubted whether any pure tone gives the full impression of an *s*, having often experimented with bird-calls of about the right pitch. In my published papers I find references to wave-lengths 31·2 mm., 1·304 in. = 33·1 mm., 1·28 in. = 32·5 mm.[5] It is true that these are of a pitch too high for Köhler's optimum, which at ordinary temperatures corresponds to a wave-length of 40·6 mm., or 1·60 inches; but they agree pretty well with the pitch found for actual hisses in my observations with Enock.

Prof. Titchener has lately returned to the subject. In a communication to the American Philosophical Society[6] he writes:—

It occurred to me that the question might be put to the test of experiment. The sound of a Galton's whistle set for 8400 v.d. might be imitated by the mouth, and a series of observations might be taken upon material composed partly of the natural (mouth) sounds and partly of the artificial (whistle) tones. If a listening observer were unable to distinguish between the two stimuli, and if the mouth sound were shown, phonetically, to be a true hiss, then it would be proved that the whistle also gives an *s*, and Lord Rayleigh would be answered.

The experiment was more troublesome than I had anticipated; but I may say at once that it has been carried out, and with affirmative result.

A whistle of Edelmann's pattern (symmetrical, like a steam whistle) was used, actuated by a rubber bulb; and it appears clear that a practised operator was able to imitate the whistle so successfully that the observer could not say with any certainty which was which. More doubt may be felt as to whether the sound was really a fully developed hiss. Reliance seems to have been placed almost exclusively upon the position of the lips and tongue of the operator. I confess I should prefer the opinion of unsophisticated observers judging of the result simply by ear. The only evidence of this kind mentioned is in a footnote (p. 328): "Mr. Stephens' use of the word 'hiss' was spontaneous, not due to suggestion." I have noticed that sometimes a hiss passes momentarily into what may almost be described as a whistle, but I do not think this can be regarded as a normal *s*.

Since reading Prof. Titchener's paper I have made further experiments with results that I propose to describe. The pitch of the sounds was determined by the sensitive flame and sliding reflector method, which is abundantly sensitive for the purpose. The reflector is gradually drawn back from the burner, and the positions noted in which the flame is unaffected. This phase occurs when the burner occupies a *node* of the stationary waves. It is a place where there is no to and fro *motion*. The places of recovery are thus at distances from the reflector which are (odd or even) multiples of the half wave-length. The reflector was usually drawn back until there had been five recoveries, indicating that the distance from the burner was now $5\times\frac{1}{2}\lambda$, and this distance was then measured.

The first observations were upon a whistle on Edelmann's pattern of my own construction. The flame and reflector gave $\lambda=1·7$ in., about a semi-tone flat on Köhler's optimum. As regards the character of the sound, it seemed to me and others to bear some resemblance to an *s*, but still to be lacking in something essential. I should say that since my own hearing for *s*'s is now distinctly bad, I have always confirmed my opinion by that of other listeners whose hearing is good. That there should be some resemblance to an *s* at a pitch which is certainly the predominant pitch of an *s* is not surprising; and it is difficult to describe exactly in what the deficiency consisted. My own impression was that the sound was too nearly a pure tone, and that if it had been quite a pure tone the resemblance to an *s* would have been less. In subsequent observations the pitch was raised through

[1] Nature, vol. xci., p. 319, 1913.
[2] *Phil. Mag.*, vol. xvi., p. 235, 1908. Scientific Papers, V., p. 486.
[3] Nature, vol. xci., p. 451, 1913.
[4] Nature, vol. xci., p. 558, 1913.
[5] Scientific Papers, I., p. 407; II., p. 100.
[6] Proceedings, vol. liii., August—December, 1914, p. 323.

$\lambda = 1\cdot6$ in., but without modifying the above impressions.

Wishing to try other sources which I thought more likely to give pure tones, I fell back on bird-calls. A new one, with adjustable distance between the perforated plates, gave on different trials $\lambda = 1\cdot8$ in., $\lambda = 1\cdot6$ in. In neither case was the sound judged to be at all a proper *s*, though perhaps some resemblance remained. The effect was simply that of a high note, like the squeak of a bird or insect. Further trials on another day gave confirmatory results.

The next observations were made with the highest pipe from an organ, gradually raised in pitch by cutting away at the open end. There was some difficulty in getting quite high enough, but measures were taken giving $\lambda = 2\cdot2$ in., $\lambda = 1\cdot9$ in., and eventually $\lambda = 1\cdot6$ in. In no case was there more than the slightest suggestion of an *s*.

As I was not satisfied that at the highest pitch the organ-pipe was speaking properly, I made another from lead tube, which could be blown from an *adjustable* wind nozzle. Tuned to give $\lambda = 1\cdot6$ in., it sounded faint to my ear, and conveyed no *s*. Other observers, who heard it well, said it was no *s*.

In all these experiments the sounds were *maintained*, the various instruments being blown from a loaded bag, charged beforehand with a foot blower. In this respect they are not fully comparable with those of Prof. Titchener, whose whistle was actuated by squeezing a rubber bulb. However, I have also tried a glass tube, 10·4 in. long, supported at the middle and rubbed with a resined leather. This should be of the right pitch, but the squeak heard did not suggest an *s*. I ought perhaps to add that the thing did not work particularly well.

It will be seen that my conclusions differ a good deal from those of Prof. Titchener, but since these estimates depend upon individual judgment, perhaps not uninfluenced by prepossessions, they are not fully satisfactory. Further independent aural observations are desirable. I fear a record, or ocular observation, of vibrations at so high a pitch is hardly feasible.

I may perhaps be asked if a characteristic *s*, having a dominant pitch, is not a pure tone, what is it? I am disposed to think that the vibration is irregular. A fairly defined pitch does not necessitate regular sequences of more than a few (say 3–10) vibrations. What is the state of affairs in an organ-pipe which does not speak well, or in a violin string badly bowed? An example more amenable to observation is afforded by the procession of drops into which a liquid jet breaks up. If the jet is well protected from outside influences, the procession is irregular, and yet there is a dominant interval between consecutive drops, giving rise under suitable conditions to a sound having a dominant pitch. Vibrations of this sort deserve more attention than they have received. In the case of the *s* the pitch is so high that there would be opportunity for interruption so frequent that they would not be separately audible, and yet not so many as to preclude a fairly defined dominant pitch. I have an impression, too, that the *s* includes subordinate components decidedly graver than the dominant pitch.

Similar questions naturally arise over the character of the *sh*, *f*, and *th* sounds.

RAYLEIGH.

GAUGES.

INTERCHANGEABILITY forms the basis of manufacture wherever there are a large number of articles to be made, and the processes required in order to secure it are well understood. The system makes it possible to subdivide the manufacture of any part into many small processes, each effected by one worker, aided by machine or hand tools, who acquires great skill in his particular operation. The parts so made must be capable of being assembled with the minimum labour; in fact, assembling ought to consist merely of putting together parts selected at random from stocks of details, with the certainty that these will fit without any additional tool work on the part of the assembler. Each operation performed in the making of any part must give to that part definite dimensions within prearranged limits. The precise dimensions and limits are chosen with a view to securing running, push, driving, or shrinking fits, according as will be required in the assembling operations. Gauges by means of which the results of each operation may be tested thus become a necessity in the manufacture of interchangeable parts. These gauges are generally of the limit form. Very large numbers of these gauges are required in the production of munitions.

Suppose the operation to consist of boring a hole nominally 1 in. in diameter, and that the finished hole must not exceed 1·003, nor be less than 0·997 in. in diameter. The gauge employed would be cylindrical, having one end 1·003, and the other end 0·997 in. in diameter. If the smaller end can go into the hole, the hole is not less than 0·997 in. in diameter, and if the larger end cannot go in, the hole is not larger than 1·003 in. diameter. By use of a gauge of this kind, any workman of ordinary intelligence may produce work having a high degree of accuracy.

It is obvious that the gauges employed must be much more accurate in dimensions than the work which they are employed to check. Thus the gauge mentioned above would have its larger end probably within the limits 1·0031 and 1·0029, the variation permitted being one ten-thousandth inch above or below the rated size. Further, gauges must be made of very hard material in order to reduce wear, and must have well-finished surfaces. The hard steel used for this purpose is often of such quality as to require annealing once or twice before the necessary machining operations can be completed. After machining nearly to the finished size, the gauge is hardened, a process which generally warps the material.

To correct this, and to bring the gauge to the proper dimensions, grinding and lapping by machines or hand is required. It will thus be understood that the whole operation of gauge-making is one which requires great skill, and a special plant.

Many of the gauges used in engineering manufactures are made by firms who lay themselves out specially for this class of work; in other cases the manufacturing firms make their own gauges. The latter plan has nothing against it, provided that the whole of the parts required in the finished products of the firm are made in their own factory. This is a point of importance at the present time, when most engineering firms have been called into the making of munitions. It is clear that the produce of any one firm producing certain parts must agree, within the prescribed limits of accuracy, with that of any other firm making the same parts. Hence all must be supplied with gauges having like limits of accuracy.

It is well known, as has been pointed out by a correspondent in the *Morning Post*, that the firms of gauge-makers have not been able to keep pace with the demand, and that many firms have been hindered in the starting of the manufacture of munitions by delay in the supplying of gauges. It is very easy to say now that the emergency might have been foreseen earlier. A very useful suggestion was made at a recent meeting of the Institution of Mechanical Engineers to the effect that all gauges should be made and supplied from a central factory. It may not be altogether a dream to imagine such a factory under direct government control, as is the case in Woolwich Arsenal, and working in conjunction with the National Physical Laboratory in order that standards may be maintained. Such an institution would be of great benefit to engineering manufacture, quite apart from the present war conditions, and could be worked so as to secure the standardisation of dimensions in a similar way to that in which are maintained our standards of weights used in distributive trades.

The National Physical Laboratory has recently been carrying out a useful piece of work in determining the desirable manufacturing limits for B.A. screws. Gauges for testing screws present peculiar difficulties in manufacture, as will be realised from what has been said above. The "fit" of a screw having a V thread in a tapped hole depends chiefly upon the effective diameter of the threads (*i.e.*, the diameter measured between the sloping sides of the thread), on the pitch, and on the correctness of the angle of the V. The National Physical Laboratory has issued tables giving recommendations (some of them provisional) for B.A. threads Nos. 0, 1, 2, 3, 4, 5, 6. The scope and importance of the recommendations may be understood by examination of the accompanying table, which we have abstracted from a number of tables in the report.

Table for B.A. Threads. No. 0.

All dimensions are in millimetres.

—	Standard	Finished parts		Tools			Gauges				
		Limits for screws	Limits for nuts and tapped holes	Limits for taps	Limits for dies	Limits for taps to cut dies	Screwed plug *a*	Go in plug *c*	Not go in plug *d*	Go in ring *e*	Not go in ring *f*
Full diameter	6·000	5·933 6·000	6·067 6·200	6.133 6·167	6·033 6·067	6·000 6·033	5·993 6·000			6·000	5·933
Effective diameter ...	5·400	5·267 5·333	5·467 5·533	5·433 5·467	5·333 5·367	5·267 5·300	5·380 5·387				
Core diameter	4·800	4·600 4·733	4·800 4·867	4·733 4·767	4·633 4·667	4·567 4·600	4·767 4·773	4·800	4·867		
Pitch, over 10 threads	10·000	9·985 10·015	9·985 10·015	9·971 10·000	10·000 10·029	9·9855 10·0145	9·997 10·003				
Angle of V	47½	42½° 52½°	42½° 52½°	45½° 49½°	45½° 49½°	45½° 49½°	46½° 48½°				

The gauges recommended are (*a*) a screwed plug gauge; (*b*) a screwed ring gauge; (*c*) a plain cylindrical "go in" gauge; (*d*) a plain cylindrical "not go in" gauge; (*e*) a "go in" ring gauge; (*f*) a "not go in" ring gauge. Gauge (*b*) would be specified to have the same thread form as the plug gauge (*a*) and would be checked by its fit upon the latter. Gauge (*c*) is of standard nominal core diameter, and should fit in gauge (*b*); gauges (*c*) and (*d*) serve the purpose of testing the core diameters of units and tapped holes. Gauges (*e*) and (*f*) are for testing the full diameters of screws.

The results of the investigation are bound to be of service at the present juncture to instrument makers and others using B.A. threads. The National Physical Laboratory is prepared, pending an authoritative decision on the matter, to certify screws, etc., which fall within the suggested limits, as B.A. screws, taps, or gauges.

FAUNA ANTARCTICA.[1]

DR. BRUCE is to be congratulated on the publication of the fourth volume of the scientific results of the voyage of the *Scotia*. This stately publication contains no fewer than nineteen reports (all by British investigators) on the vertebrate animals collected by the expedition, and it seems to us well worthy of the generosity, notably on the part of Sir Thomas Glen Coats, which has made its publication possible. Many of the reports have appeared previously in the transactions of scientific societies, as is carefully noted in each case, but the utility of having all the papers together is obvious.

Beginning with the mammals, we find a report by Dr. Bruce on the dimensions and weights of the Antarctic seals captured by the *Scotia*, and the editor also contributes a series of fine photographs of the Weddell seal, the sea-leopard, the crab-eater, the Ross seal, and the Patagonian sea-lion. Dr. R. N. Rudmose-Brown gives a very interesting account of the habits of four Antarctic seals (Weddell, crab-eater, sea-leopard, and Ross seal), and the value of his personal observations is increased by numerous beautiful photographs. Prof. David Hepburn deals with the brain, the abdominal viscera, the respiratory organs, and the urogenital system of a young male Weddell seal (*Leptonychotes weddelli*); Prof. Robert Thomson with the skeleton of the Ross seal (*Ommatophoca rossi*); and Dr. Harold Axel Haig with the structure (macroscopic and microscopic) of a fœtal sea-leopard, *Stenorhynchus leptonyx*) and with the minute structure of the central nervous system of the Weddell seal. Dr. Bruce gives data in regard to seven Antarctic whales, and also discusses an interesting piebald porpoise (probably *Lagenorhynchus cruciger*). Mr. Theodore E. Salvesen's graphic account of the southern whale fisheries has been recently reviewed in NATURE (vol. xciv., p. 678, February 18, 1915).

FIG. 1.—*Leptonychotes weddelli* (Weddell Seal). From "Report on the Scientific Results of the Voyage of s.y. *Scotia*."

Turning to the birds, we find a masterly account of the birds of the South Orkney Islands, the Weddell and adjacent seas, and Gough Island, by Mr. Eagle Clarke, of the Royal Scottish Museum. The birds observed and collected by the *Scotia* at other places have been dealt with in a number of short papers by the late Lieut. Lewis N. G. Ramsay, a young zoologist of great promise, who was, alas! killed at Neuve Chapelle in March of this year. Dr. R. N. Rudmose-Brown gives a vivid picture of the habits of penguins. Profs. D. Waterston and A. Campbell Gaddes deal with some anatomical features of the Emperor penguin and with the development of Gentoo and Adelie penguins. The extraordinary curvature of the cervical region of the penguin's vertebral column is carefully discussed, and an interesting contrast is made between the development of the duck's wing and that of the penguin's paddle.

An important report on the Antarctic fishes comes from the skilful hands of Mr. C. Tate Regan, who describes seven new genera and twenty-one new species. The first of the new genera, Eugnathosaurus, is based on a remarkable head taken off Coats Land at a depth of 1410 fathoms. A collection of over a hundred species of Atlantic fishes is briefly dealt with by Mr. R. S. Clark (now acting as zoologist on Sir Ernest Shackleton's expedition), who also reports on half-a-dozen fresh-water fishes from Buenos Aires. Prof. W. A. Herdman describes the Tunicates, fifteen or sixteen species represented by about two hundred specimens. The only new species (*Fungulus antarcticus*) is a very remarkable form belonging to the deep-sea genus Fungulus, a single specimen of which was obtained by the *Challenger* in 1882, between the Cape of Good Hope and Kerguelen, from a depth of 1600 fathoms. Nearly 3000 miles away, but again in the far south and in very deep water (2485 fathoms), the *Scotia* species was obtained, and again but a single specimen. The limit of the Chordate sub-kingdom is found by many zoologists in the remarkable animals known as Pterobranchia, and the *Scotia* explorers were fortunate enough to secure numerous specimens of

[1] Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of S.Y. *Scotia* during the Years 1902, 1903, and 1904, under the leadership of W. S. Bruce. Vol. iv., "Zoology." Parts ii–xx. Vertebrates. Pp. xi+505+62 plates+2 maps. (Edinburgh: The Scottish Oceanographical Laboratory, 1915.) Price £2 10s. net.

a very interesting new species of Cephalodiscus, of which a fine account has been given by Drs. S. F. Harmer and W. G. Ridewood, whose previous studies of these strange types are well known. Thus we come, in the meantime, to the end of a valuable series of contributions to the marine zoology of the far south, contributions which do great credit to the investigators at home and to Dr. Bruce and his fellow-workers on the *Scotia.* We are told in the preface that there is material for six more volumes, and we hope that these will see the light in brighter days. If they sustain the standard of what has been already published they will do well.

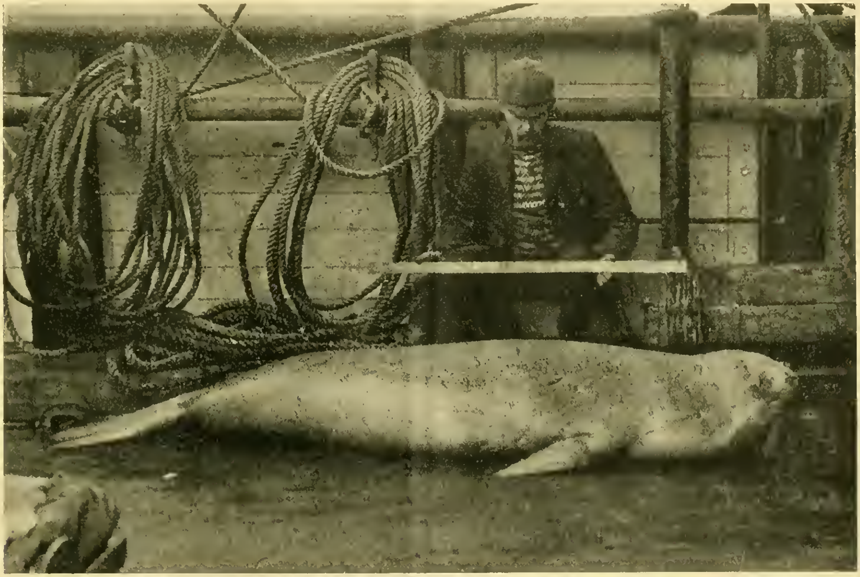

FIG. 2.—Ross Seal (*Ommatophoca rossi*) and Dr. Pirie on board the *Scotia*. From "Report on the Scientific Results of the Voyage of s.y. *Scotia*."

NOTES.

IT is stated in the *Pharmaceutical Journal* that, in consequence of the war, the meeting of the Australasian Association, which had been arranged to take place in Hobart in January next, has been postponed for a year, and that the Australasian Pharmaceutical Conference will not be held until January, 1917.

SIR A. SELBY-BIGGE (Permanent Secretary of the Board of Education since 1911) has been appointed special secretary to the committee of the Privy Council for the organisation and development of scientific and industrial research.

MR. F. W. HARBORD has been appointed honorary adviser in metallurgy to the Munitions Committee.

PROF. MELDOLA, writing as a member of the Advisory Council for the new Government scheme for the endowment of research, asks us to make it known that the article in the *Evening News* of August 2 dealing with this scheme was not written by him and that he does not identify himself with all the statements and opinions contained therein. A disclaimer was inserted in the same paper on August 5.

THE gold medal of the Company of Dyers has been awarded to Prof. A. G. Green, University of Leeds, and to Mr. W. Johnson, a research student of the University of Leeds, for research work in connection with the art of dyeing. The special research which was the occasion of the award was an investigation into the constitution of aniline black.

THE Weber-Parkes prize of the Royal College of Physicians for 1915 has been awarded to Dr. Noel Dean Bardswell.

THE Paris Academy of Medicine has accepted the legacy of Dr. M. Sigaut of 8,000 francs, the interest of which will be used to establish a prize to be known as the Dr. Max Sigaut prize. The prize will be awarded every two years for the best memoir on early diagnosis and the best treatment in cancer of the digestive tract.

THE Secretary of State for the Colonies has appointed a committee to consider and report upon the present condition and the prospects of the West African trade in palm kernels and other edible and oil-producing nuts and seeds and to make recommendations for the promotion, in the United Kingdom, of the industries dependent thereon. The committee as at present constituted is composed of Mr. Steel

Maitland (chairman), Sir G. Fiddes, Sir F. Lugard, Sir Hugh Clifford, Sir Owen Philipps, Mr. G. A. Moore, Mr. T. Walkden, Sir W. G. Watson, Bt., Mr. L. Couper, Prof. W. R. Dunstan, Mr. T. Middleton, Mr. T. Worthington, and Mr. T. Wiles. The secretary is Mr. J. E. W. Flood, of the Colonial Office.

THE death is announced of Dr. B. Fischer, Professor of Hygiene and Bacteriology in the University of Kiel, who recently succumbed to heart-failure near Ypres. In the early days of bacteriology he studied the action of antiseptics and disinfectants upon bacteria, and afterwards made important contributions on the phosphorescent and chromogenic bacteria and on bacterial structure and classification. The latter formed the subject of a series of lectures, an English translation of which appeared under the title of "The Structure and Functions of the Bacteria," which has passed through two or three editions and forms an admirable introduction to the more botanical side of bacteriology.

THE death is announced of Madame Osterberg, the head of the Swedish physical training movement in England. In 1880 she was appointed superintendent of the physical training department of the London School Board. In 1885 she started at Hampstead the first college in this country for teaching Swedish drill, which in 1895 was moved to Dartford Heath. The college was enlarged several times, the curriculum becoming more scientific, and a laboratory was added some years ago for research and experiment. Some eighteen months ago Madame Osterberg desired to relinquish the active direction of the work of the college. In so doing she wished, in the national interest, to secure the continuation of the work which had been so successfully developed. With this purpose in view she offered to transfer the college to the Government. For reasons in no way connected with the college it was found impracticable to accept the offer, and Madame Osterberg was advised to create a trust. Almost her last act before her death was to sign the trust deed, vesting her property in a trust with the object of carrying on the college in the national interest on its existing lines.

WE regret to note the death of Major A. M. Downie, of the 5th Highland Light Infantry. Major Downie was wounded on July 12 during operations in the Gallipoli Peninsula, and died on July 23. He was well known in engineering circles in Glasgow; he was educated at Allan Glen's School and at Glasgow University, where he took the degree of B.Sc. in engineering. At a comparatively early age he was appointed managing director of Messrs. D. Stewart and Co., Ltd., where his attainments proved of great service in developing the specialities of the firm—sugar machinery.

ACCORDING to a German wireless message, the death has just occurred, at Lichterfelde, Berlin, at the age of sixty-nine years, of Dr. Richard Kiepert, the cartographer.

WE regret to record the death of Rear-Admiral Benjamin Franklin Isherwood, who was engineer-in-chief of the United States Navy during the American Civil War. A short account of his career is given in *Engineering*. He was trained at the Albany Academy, and his early practical work was connected with railway construction. He was one of the first members of the Engineer Corps of the United States Navy, and saw service in the Mexican War in 1846 in the *Princeton*, the first screw-propelled vessel of the United States Navy. He was appointed engineer-in-chief of the navy in 1861. On his retirement he took up his residence in New York and devoted his energies to scientific research and literary work.

THE annual congress of the British Archæological Association will be held in the Isle of Wight from August 18–21 inclusive. On the evening of the opening day the president, Mr. C. E. Keyser, will deliver his presidential address at Ryde. On August 19 a joint meeting will be held with the Hampshire Field Club and Archæological Society, and arrangements have been made for visits to various places of interest on that day and on the concluding days of the meeting.

THE autumn meeting of the Institute of Metals will be held in the rooms of the Chemical Society on September 17. The following papers may be expected to be communicated:—The corrosion of gun-metal, Dr. C. H. Desch; metallic crystal twinning by direct mechanical strain, Prof. C. A. Edwards; notes on the copper-rich kalchoids, Profs. Brinton and S. L. Hoyt; the constitution of brasses containing small percentages of tin, Dr. O. F. Hudson and R. H. Jones; (*a*) structural changes in industrial brasses, (*b*) hardness of copper-zinc alloys, Dr. D. Meneghini; specifications for alloys for high-speed superheat steam turbine blading, W. B. Parker; the physical properties of metals as functions of each other, Dr. A. H. Stuart; detection of internal blow-holes in metal castings by means of X-rays, C. H. Tonamy; a thermostat for moderate and high temperatures, J. L. Haughton and D. Hanson.

IT is intended to celebrate the twentieth anniversary of the New York Botanical Garden in Bronx Park during the week beginning on September 6 next. In addition to meetings in the garden itself, there are to be visits to Staten Island for the study of the coastal flora, to the pine barrens of New Jersey, and to the Brooklyn Botanical Garden.

THE general programme of the ninety-seventh annual meeting of the Société Helvétique des Sciences naturelles to be held at Geneva on September 12–15 has now been issued. It will be remembered that this year is also the centenary of the foundation of the society. On September 13 the president, Prof. Amé Pictet, will deliver the opening address, and a lecture will be given by Prof. A. Heim, of Zurich, on new light in the investigation of the Jura Mountains. On September 14 the sectional meetings will take place, and on the concluding day the following lectures have been arranged:—Prof. P. L. Mercanton, of Lausanne, on the results of forty years' measurements of the Rhone glacier; Dr. Fritz Garasin, of Bale, on an archipelago in the Pacific Ocean: the Loyalty Islands; and Dr. E. Rübel, of Zurich, on the international plant geography excursion through North America. The presidents of the various sections at this year's meeting are:—Mathematics and astronomy, Prof. H. Fehr; physics and geophysics, Prof. C. E. Guye; geography and mineralogy, Prof. Ch. Sarasin; chemistry, Dr. F. Reverdin; botany, Dr. J. Briquet; zoology, Dr. M. Bedot; entomology, Dr. Arnold Pictet; anthropology and ethnography, Dr. Eugène Pittard.

STUDENTS of the mythology of primitive races have hitherto mainly dealt with the problem from the point of view of folklore and philosophy. Many tabulations of the incidents out of which the legends have been built up have been made, but these have been as a rule merely mechanical. It shows the liberal definition of scientific research in the Geological Survey of Canada that it has published, as Museum Bulletin No. 16, an elaborate disquisition by Mr. Paul Radin on the literary aspects of North American mythology. When once we admit that in dealing with primitive mythology we are discussing literature in the true sense of the word, it becomes inevitable to apply to it the same methods of analysis and criticism that we apply to any modern literature, paying due regard to the personality of the author or author-*raconteur,* his literary and stylistic peculiarities. The author of this paper deals specially with the theories of Ehrenreich and other German writers, who argue that there must be a single original and correct version of every myth. The essay is interesting and serves to modify in some degree current views of the methods by which this body of legend was constructed.

IN *Man* for August, the Hon. J. Abercromby describes the few remaining examples of plastic art from the Grand Canary. There is a little difficulty about some of the specimens, as a collection from Mexico seems to have been mixed up with local articles in the Museum of Las Palmas. One specimen, perhaps the image of a goddess, seems to be of the steatopygous type, and another, showing an abnormal development of the biceps, may represent a wrestler. The steatopygous type cannot be Mexican, as this feature is believed to be absent in art from that country. As steatopygy prevailed among the Berber-speaking tribes of North Africa and the Sahara, and shows itself in some early figurines from the Ægean, it is possible that it may have extended to the Grand Canary. The examples illustrated are exceedingly rude, but they are interesting as examples of a very primitive school of art.

IN *Folk-lore* for June, Mr. W. J. Perry discusses Myths of Origin and the Home of the Dead in Indonesia. He arrives at the conclusion that the land of the dead, when situated on earth, is usually in the direction of the land whence the people who believe in it suppose themselves to have come. If the journey of the spirit be over water, a canoe for its use is generally provided, or in some cases the corpse may be actually conveyed to the homeland. When the home of the dead is a mountain, it implies that the tribe traces its origin to a mountain, and tree-disposal is often accompanied by a myth of origin from some kind of tree. Interment, he suggests, implies an origin from the earth, and the use of stone sepulchres implies a myth of origin from stones. These conclusions may be supported by the evidence from Indonesia, but they will not be accepted as of general application, and a treatment of the subject from the comparative point of view is much to be desired.

IN Memoir No. 75 of the Department of Mines, Canada, Mr. F. G. Speck contributes an account of the decorative art of the Indian tribes of Connecticut. Much work has recently been done among the eastern Algonkin tribes, many specimens of their art industries have been collected, and information has been procured from several aged Indians of the Mohegan and Niantic tribes of eastern Connecticut. The artistic capacity of these people is chiefly shown in painting on baskets, while decorative wood carving on household utensils and sometimes upon implements was common, but bead-work was only of secondary importance. This monograph is therefore specially devoted to basketry, and the materials, implements, and designs are fully described. Some of this work is highly ingenious and beautiful, and the memoir may prove useful to the authorities of some of our technical schools.

PROF. W. H. THOMPSON, who occupies the chair of physiology at Trinity College, Dublin, has published a little pamphlet on "Food Values," the proceeds of the sale of which will be devoted to the Dublin University Voluntary Aid Detachment Hospital. It deals primarily with the food supplies in Ireland, but may be applied, so far as its chief data are concerned, to the food supply of any nation. In these days, when economy is so urgent, its appearance is very timely. It deals in clear language which "he who runs may read" with the fundamental principles of diet. Mere weight is no criterion of the energy value of any food. The amount of water must be deducted, and many of the most expensive foods contain most water. After this the chemical constitution of the remainder (proteins, fats, carbohydrates, salts) must be considered, and, finally, the amount of each of the constituents which is digestible. The latter factor is much influenced by the method of cooking adopted. All these points are considered, and a number of useful illustrations help to elucidate the text. Emphasis is put upon the substitution of the cheaper forms of the more highly nutritious vegetable foods for those of animal origin. It is here that cooking (the weak point in many British households) is all-important. The bad or insufficient cooking of meaty foods does not profoundly affect their digestibility, although it influences their appetising quality, a by no means unimportant matter; but a badly cooked vegetable diet is not only destitute of the latter quality, but is very largely incapable of being digested. We are glad to see that a number of useful recipes are given, which enhance the practical value of this useful pamphlet.

THE economic resources of German South-West Africa form the subject of an article in the Bulletin of the Imperial Institute, vol. xiii., No. 2, just issued.

The value of the article is enhanced by a useful map showing the railways, rivers, diamondiferous areas, etc., and an account of the geology, meteorology, mineral resources, and agricultural conditions of the country is given. Diamonds were discovered in 1908, and the value of the output in 1912 was 1,520,704*l*. Gold, marble, and various other economic minerals of importance are found. As regards agriculture, stock-raising has received considerable attention, and in the middle districts and south, where irrigation is possible, a good many crops are grown. Tobacco-growing has been encouraged at the Government station Okahandja, and cotton of good quality has been grown experimentally. Grapes, peaches, apricots, etc., have also been successfully grown, and various dry-country trees are being grown at the forest stations.

Under the title of "The Wonderland of California," Mr. Herman Whitaker, in the July issue of the *National Geographic Magazine*, deals with some of the magnificent scenery of the peninsula. The paper is, as usual, illustrated by a splendid collection of photographs, among which those of the entrance of the Golden Gate, the magnificent trees in the State Redwood Park near Boulder Creek, the Bridal Veil waterfalls on Merced River, the views of the Yosemite Valley, and of the mighty granite peak known as El Capitan, are particularly impressive. Now that the Continent is likely to be barred for some time to come, travellers in search of the beautiful may well direct their attention to the country described in this pleasant paper.

Inasmuch as the wheat-producing capabilities of the non-belligerent nations is now a matter of the most vital importance, it is disconcerting to find that the Hessian fly, during the past season, has inflicted immense damage to the wheat crop of the United States, millions of bushels having been ruined. What is more, unless strenuous efforts are immediately made, the devastation will assume far more alarming proportions during the coming year. To avert this, if possible, the United States Department of Agriculture has just issued a leaflet, which cannot be too widely read by British farmers, for this country is by no means immune to attacks from this insidious parasite. The farmers over the vast area now infected are exhorted to act on the advice ignored by them, in spite of repeated warnings, during 1914. It is once more pointed out that this pest can be practically exterminated by adopting the simple precaution of delaying the autumn wheat-sowing until after the adult flies emerging from the "flax-seed" or larval cases adhering to the straw of the summer wheat have perished, which they must do soon after assuming the adult stage. They will thus die without leaving offspring, since they will find no nidus for their eggs. Wherever possible, all stubbles are to burned, and where this is not possible they should be deeply ploughed in and the ground rolled. Further, rotation of crops should be adopted whenever possible. Where good seed-wheat is sown on generous ground, a mild attack of this fly may even prove beneficial, since the early developing larvæ destroy the first shoots and cause the plant to "tiller." Maps showing the best average dates for sowing, according to latitude, and diagrams illustrating the life-history of the fly, add immensely to the value of this leaflet.

From the *Kew Bulletin* we learn that the new laboratory for the exclusive investigation of problems in plant pathology is now in use. The laboratory has been formed by the alteration of two Georgian cottages facing Kew Green, and contains several research rooms and a large library. The cottages were formerly houses in the occupation of Ladies of the Bedchamber when the Court was in residence at Kew, and the plaster ceilings in some of the rooms are of considerable beauty. Until now, much of the Board of Agriculture's pathological work has been carried out at Kew in the Jodrell Laboratory, but owing to the increasing importance of the work, the establishment of a separate institute with its own staff of plant pathologists has become an imperative necessity. The attention of the staff will be devoted primarily to the investigation of diseases caused by fungi, both at home and in our Colonies, and special research in connection with important problems in plant pathology will also be undertaken. Mr. A. D. Cotton, assistant in the herbarium, has been promoted to a first-class assistantship in connection with the new laboratory, and Mr. W. B. Brierley, of Manchester University, has also been appointed a first-class assistant. A temporary assistant and a preparer comprise the staff up to the present. A portion of the laboratory is being used temporarily by the entomologist of the Board of Agriculture, so that opportunity is also afforded for the investigation of plant diseases caused by insects.

Owing to the high price of wheat flour, attempts are being made in the West Indies to replace part of the imported flour by locally prepared products. An analysis of a sample of banana flour from Jamaica is given in the current number of the Bulletin of the Imperial Institute (vol. xiii., No. 2). Compared with wheat flour or maize meal, it was found to have a lower nutritive value, owing to the much smaller percentage of proteins. The meal has rather a pronounced aroma, but as a partial substitute for wheat flour or maize meal it may prove useful locally.

In the *Indian Forest Records*, vol. v., part vi., of May, 1915, Mr. R. S. Hole describes a new species of forest grass from Burma under the name *Spodiopogon lacei*. The paper is illustrated by excellent photographs of the grass and drawings of the details of the structure of the spikelets and flowers, the number of the spikelets in the raceme and of flowers in each spikelet being important features in the genus. In this species the racemes consist of three to nine spikelets, and are usually two-flowered.

The flowers of Milton form the subject of the first instalment of a paper, by the veteran Canon Ellacombe, in the *Gardener's Chronicle* for July 17. It will be remembered that he has already written on the flowers of Chaucer, Spenser, and Gower, and the present paper is of equal value to its predecessors. Milton had not the knowledge of plants possessed by the other three poets, but the Canon's notes are full of interest. Milton's amaranth still remains a puzzle, but as he places it in Paradise, further earthly research seems useless.

In the current number (vol. xiii., No. 2) of the Imperial Institute Bulletin, Prof. J. B. Harrison and Mr. C. K. Bancroft contribute a paper on "The Field and Forest Resources of British Guiana." Some 55,770,000 acres of land are estimated to be open for beneficial occupation, some 9,000,000 of which are easily accessible. Rice is a product which may be grown over large areas, and the success which has attended its culture shows that the colony might well become the granary of the West Indies in this particular grain. Forestry development is limited by difficulties of transportation, but of timber there is abundance and of good quality. Balata, which occurs all over the colony, is one of the most important forest trees, and greenheart is perhaps the best known of all the timbers of British Guiana.

At the monthly general meeting of the Zoological Society of London, held July 21, special attention was directed to the hatching, in the menagerie, of a white-browed wood swallow and two white storks. Since the total number of visitors to the Gardens between January 1 and June 30 shows a decrease of 120,993, it would seem that the war has, during this period, seriously crippled the Society; but matters are, happily, not so bad as this statement, in itself, would seem to show, for the receipts for admission at the gates, as compared with the corresponding period for the last ten years, show a deficiency of no more than 404*l*., which may well be made up during the next few months.

The investigation of another egg of Ornithorhynchus, described in the current number of the *Quarterly Journal of Microscopical Science* (vol. lxi., part i.), has afforded Profs. Wilson and Hill an opportunity of revising their views on the subject of the so-called primitive or archenteric knot. This structure was supposed to mark the position of the blastopore, but to come into relation with the primitive streak only secondarily, originally lying outside the embryonic shield. Both Keibel and Assheton criticised this interpretation, and suggested that the supposed archenteric knot in the younger stages of Ornithorhynchus might in reality be the yolk-navel. This view is definitely accepted by Profs. Wilson and Hill, who state that they feel with Assheton that "another stumbling-block has been removed from the path of the student of mammalian embryology."

The way in which animals learn by the method of so-called trial and error has now been rendered fairly comprehensible by a considerable body of experimental work, largely conducted in the psychological laboratories of the United States. In a recent "Behavior Monograph" (No. 10) of the well-known series edited by Prof. J. B. Watson, Mr. J. L. Ulrich discusses the distribution of effort in learning in the white rat. The chief questions to which he seeks an answer are these: Given three "problems" to be practically solved by behaviour which has to be learnt, what in each several case is the optimum distribution of trials; once in three days, once a day, or thrice a day? The answer seems to be that once in three days gives the minimum number of trials before the lesson is completely learnt, but that with three trials a day the lesson is learnt in a shorter period of time. It seems, too, that when three modes of behaviour are learned abreast, trials in each being made on the same day, infrequent practice, say one trial in each *per diem*, is advantageous, and that under these conditions a much larger number of trials is required for the solution of each of the problems than is required when the modes of behaviour are learnt one at a time. Physiological interpretation is tentatively suggested.

In a series of three papers published by the Edinburgh and East of Scotland College of Agriculture, Dr. J. P. M'Gowan discusses the epidemiology and pathology of three important animal diseases, swine-fever, louping-ill of sheep, and chicken-cholera. Louping-ill he considers to be caused by the *Bacillus bipolaris septicus ovium*; the disease is divisible into several varieties, and a "pseudo-louping-ill" is also known. Swine-fever is generally considered to be caused by a "filter-passer," but the view is expressed that the evidence for this being the case is far from complete. Chicken-cholera is caused by the *Bacillus pullorum*, but there are probably several varieties of this organism, and "white diarrhœa" of poultry and "white scour" of lambs are probably caused by similar micro-organisms.

In an article on the production of X-ray bulbs in France (*La Nature*, July 10) it is pointed out that the statement that suitable French glass was not available at the outbreak of war was inaccurate. Since 1904 Appert Bros. have made suitable glass, and that though glass blowers preferred Thuringen glass, it was on grounds of economy only, and the Clichy factory was able to supply similar glass when the stocks became exhausted. From analyses of German glass by M. Matignon it was found possible to imitate it, and glass even more transparent to X-rays is now made. Pilon's modification of the Coolidge tube is described, showing how satisfactory cooling of the antikathode is obtained. The 1915 model gives a steady discharge even for such long periods as 1 hour 20 minutes, with perfect control of the character of discharge.

La Nature for July 10 also contains a very interesting article on the torpedo. Reference is made to the early history of the torpedo; to Whitehead's early pattern of a speed of only 6 knots, and capable of covering a distance of 600 metres. The great progress made to the present torpedo, with a speed of 45 knots and 10,000 metres range, carrying a charge of 150 kilos. of high explosive, is a notable achievement. An excellent description is given of the manner in which the difficulties of control of immersion and direction have been overcome by means of the hydrostatic balance and gyroscope. As is well known, compressed air (at 150 kilos. per square centimetre) is used for the engines. On expansion it is very materially cooled, and a reference is made to a modern arrangement for re-heating the air by injection of an alcohol or petrol spray, together with a fine spray of water—a method which leads to a great increase in speed and run of the torpedo. The article deals further with the interesting experimental station of the Schneider firm—the *Batterie des Maures*—situated in the roads of Hyères.

In a recent article (NATURE, August 5) on modern methods for the preparation of hydrogen for balloons and dirigibles, the difficulties attendant on the use and transport of acid for the well-known methods of generation from zinc or iron were mentioned. One of the greatest troubles arising from the use of gas prepared by these reactions has been due to impurities in the gas. An article in *La Nature* (July 10) deals specially with this method of preparation and the purification of the gas. Among the impurities are hydrogen arsenide, antimonide, and selenide, all poisonous gases, and which led to the death of two employees and serious illness of three others engaged at the Chalais-Meudon Aerodrome in 1900. Sulphurctted hydrogen, formed by reduction in the generators, has a very deleterious action on the varnish of the fabric, which, containing lead, is attacked, forming the sulphide, and further, by the action of moist air, on the tissue itself. Exposed metal in dirigibles is also subject to its attack. Other impurities are water vapour, carbon dioxide, and gaseous hydrocarbons, which seriously diminish the lifting power of the gas. Purification entails first washing the gas to remove acid spray, passage through a special purifier containing a moist mixture of iron sulphate and lime on sawdust, and finally through soda. The iron purifying material which has absorbed the sulphuretted hydrogen is regenerated by exposure on grids to the air. The cost of purification is stated to be 1·5 to 2 centimes per cubic metre.

An investigation by Messrs. G. K. Burgess and P. D. Merica, of the Bureau of Standards, a preliminary account of which appears in the *Journal of the Washington Academy of Sciences* for July 19, appears to provide a complete explanation of the mysterious failure of tin fusible boiler plugs. It will be remembered that these plugs are inserted in the crowns of boiler furnaces or flues and that their function is to give warning of overheating of the boiler by their melting and admitting steam to the fires. It was found that the tin of plugs which had failed had been converted in service into SnO_2, which melts at 1600° C. This oxidation was finally traced to the presence of zinc in the tin to the extent of 0·3 per cent. Plugs with this amount of impurity, when heated to 190° C. for 500 hours, develop a cellular structure, the walls of the cells consisting of oxidised zinc, to which oxidised tin is added with time, and the unoxidised tin is enclosed in the cells. Even when the tin is melted the cell walls may be strong enough to withstand the boiler pressure. The authors conclude that tin of at least 99·8 per cent. purity should be used for such boiler plugs.

The July number of the Bulletin of the American Mathematical Society (xxi., 10) contains particulars of the courses in mathematics announced for the summer semester in six of the German universities. Excluding such general items as "colloquium" and "seminar," the statistics work out as follows:—Berlin, 13 courses by 8 lecturers; Bonn, 7 courses, 4 lecturers; Frankfurt, 7 courses, 4 lecturers; Göttingen, 13 courses, 9 lecturers; Leipzig, 9 courses, 4 lecturers; Munich, 11 courses, 8 lecturers. We also note the award of the Helmholtz medal of the Berlin Academy to Prof. M. Planck, and the celebration of the seventy-fifth birthday of Prof. F. Mertens, of Vienna, on November 7, 1914, and of the seventieth birthday of Prof. Georg Cantor, of Halle, on March 3, 1915. The lists of courses do not appear to differ to any substantial degree from those published in previous years, either in the number of courses or in the character of their subject-matter. To English readers they should afford some indication of the way our enemies are maintaining their higher scientific educational systems in war-time. By "lecturers" in the preceding list we mean professors in most cases, but include other members of the teaching staffs.

We are asked by Messrs. Constable and Co., Ltd., to state that they are the English publishers of "Elementary Text-book of Economic Zoology and Entomology," by Profs. Kellogg and Doane, which was reviewed in the issue of NATURE for July 1 last.

OUR ASTRONOMICAL COLUMN.

ABSOLUTE SCALES OF PHOTOGRAPHIC AND PHOTOVISUAL MAGNITUDES.—A great piece of photometric work on which the 60-in. reflector of the Mount Wilson Observatory is engaged is the determination of absolute scales of photographic and photovisual magnitudes covering the whole range from brightest to faintest known stars. An account of the present position of the investigation has been communicated by F. A. Seares to the National Academy of Sciences (U.S.A.), vol. i., p. 307, 1915. The method employed involves the comparison of two series of images with a known variation of intensity between the exposures. The many practical difficulties have been successfully overcome at Mount Wilson by the use of wire gauze screens and circular diaphragms. The photographic scale for the intermediate stars (10–18 mags.) was first determined in two series of exposures, one set of eleven minutes and less, the other thirty to sixty minutes; numerous determinations were made. The average difference between the mean scales from the two series, derived from nine groups of stars between 10·6 and 16·8, is only 0·015 mag. The extension to the fainter objects was effected by plates which received two different exposures with the full aperture of 60 in., the longer exposures of four to five hours, the shorter approximately half an hour. The limiting photographic magnitude thus reached was about 20. The bright stars (brighter than 10 mag.) were photographed with screens or diaphragms interposed producing images comparable with those of stars between the tenth and fifteenth magnitude, obtained with the same exposure with unreduced aperture. The entire series of photographic magnitudes of 617 objects was reduced to the international zero point by making the mean brightness of white (Ao) stars near the sixth magnitude equal to the mean of their visual magnitudes in Harvard Circular 170.

The photovisual scale was obtained in precisely the same manner, isochromatic plates being employed. Final photovisual magnitudes were obtained for 339 stars between magnitudes 2·1 and 17·5. About 300 stars are common to both lists, and for these colour indices are consequently available; for the bright stars this is small, or even negative, at the seventeenth photovisual magnitude the smallest value is 0·6 or 0·7. That the faint stars are all relatively red is thus confirmed.

METEOROLOGY OF THE SUN.—A lecture delivered before the Royal Meteorological Society last March by Prof. W. G. Duffield is reported in full in the Quarterly Journal of the Society. Whilst, of course, primarily adapted to the needs of meteorologists, it is too valuable an essay on the present position of solar research to be neglected by anyone interested in such work. The subject was divided into a number of sections; one of these, dealing with the pressure in the sun's atmosphere, has special interest in consequence of Prof. Duffield's own work on the effects of pressure on spectra. Electrical conditions in the sun's atmosphere are considered in another section, containing the interesting suggestion that the "facular masses" shown on spectroheliograms owe their luminosity to a continuous display of lightning between their several parts, or to a bombardment by negative electrons. Prof. Duffield also suggests that solar rotation is the cause of sun-spots and filaments, his theory being that the differential velocities of the various layers of the solar atmosphere set up vortices; these seen end-on are sun-spots, when floating lengthwise appear as filaments. Although neither of these ideas is entirely novel, yet both go a little further than their precursors.

The paper is illustrated by a number of useful diagrams, and contains reproductions of some fine spectroheliograms.

VARIABLE STARS.—Two papers dealing with investigations carried on at Princeton Observatory appear in the Proceedings of the American Philosophical Society, No. 216. In one of these Dr. Dugan (p. 54) gives some recent results obtained in the case of the eclipsing variables RT Persei and z Draconis, both cases where the light curves have demonstrated ellipticity of figure, exchange of radiation, and possibly darkening at the limb. For RT Persei the shape of the light curve possibly indicates that the advancing side of the brighter component is brighter than the following. Some recent observations of the secondary minima show that the eclipses are now coming forty minutes earlier than the times predicted from the original elements derived from observations taken about seven years ago. Extending the period of observation by data from Harvard results in a reduction of the average period by one second. Using this shorter period the residuals reveal two periodic terms, the shorter of which closes in about 4000 eclipse periods, *i.e.* about nine years, and with a coefficient of five minutes. This is of the order of magnitude of that to be expected from the revolution of the line of apsides caused by the observed prolateness. Necessary additional observations are being undertaken. Similar results have been obtained for z Draconis. In both stars the light at minimum is distinctly redder than before. In the other paper Mr. R. J. McDiarmid deals with the algol variables, TV, TW, TX Cassiopeiæ, and T Leonis Minoris. Secondary minima have been established in the light curves of TW Cass. and T Leo. Min. The light curve of TV Cass. indicates an increase of brightness between primary and secondary eclipse, and the light curve of TX Cass. affords evidence of darkening towards the limb.

SHORT PERIOD VARIABLE STARS.—Von G. Hornig (*Ast. Nach.*, No. 4808) publishes the results of numerous observations by Argelander's method of several bright variable stars of short period. The elements calculated from these observations, together with mean light curves, are given for the three Cepheid variables RT Aurigæ (74 obs.), η Aquilæ (190 obs.), δ Cephei (396 obs.), for the Geminid variable ζ Geminorum (171 obs.), and for the two stars of β Lyræ type, μ Herculis (208 obs.) and β Lyræ (327 obs.). Elements determined by Breson from observations of ζ Geminorum, η Aquilæ, δ Cephei, and β Lyræ, and by Lau in the case of δ Cephei and β Lyræ, are compared. It is stated that the lack of correspondence in the secondary maxima of light curves determined by different observers is due to their varied "colour-perception," as are also the minor differences of more or less pointed or flattened maxima.

THE MANCHESTER MEETING OF THE BRITISH ASSOCIATION.

AS already announced, the meeting will be opened on September 7 and close on September 11. The following are among the sectional arrangements:—In Section A there will be discussions on radio-active elements and the periodic law (opened by Prof. F. Soddy); spectral classification of stars and the order of stellar evolution (opened by Prof. A. Fowler); thermionic emission (opened by Prof. O. W. Richardson); and papers by Prof. W. H. Bragg and W. L. Bragg, on X-rays and crystal structure; G. H. Hardy, on prime numbers; and Prof. A. N. Whitehead, on time, space, and relativity.

In Section B there will be an exhibition and explanation of diagrams by Dr. Dalton, illustrating his atomic theory, an experimental paper by the Hon. R. J. Strutt on active nitrogen, a discussion on smoke prevention, experimental papers on combustion, a paper by Prof. W. J. Pope on liquid crystals (with experiments), and a discussion on homogeneous catalysis.

In Section C Dr. G. Hickling will give an account of the geology of Manchester and district; Prof. W. Boyd Dawkins, papers on the classification of the tertiary strata by means of the Eutherian mammals, and the geological evidence of the antiquity of man in Britain. There will be a joint discussion with Section E on the classification of land forms (opened by Dr. J. D. Falconer). Papers will be read by Dr. A. H. Cox and A. K. Wells on the Ordovician sequence in the Cader Idris district (Merioneth); Prof. T. G. Bonney, on the north-west region of Charnwood Forest; Dr. A. Vaughan, on the shift of the western shore-line in England and Wales during the Avonian period; Prof. W. G. Fearnsides, on a contour map of the Barnsley coal seam in Yorkshire. A discussion on radio-active problems in geology (opened by Sir E. Rutherford). Papers will be read by Prof. C. A. Edwards on twinning in metallic crystals; Prof. W. J. Sollas, on the restoration of certain fossils by serial sections; Dr. J. W. Evans, on the isolation in the directions image of a mineral in a rock-slice; Dr. G. Hickling, on the micro-structure of coal; D. M. S. Watson, on vertebrate life zones in the Permo-Trias; Dr. A. Wilmore, on the Carboniferous limestone zones of north-east Lancashire; H. Day, a brief criticism of the fauna of the limestone beds at Freak Cliff and Peakshill, Castleton, Derbyshire; Dr. Jowett, a preliminary note on the glacial geology of the western slopes of the southern Pennines. It is intended to arrange, if possible, two or three afternoon geological excursions in the neighbourhood of Manchester. On Saturday there will be a whole-day field excursion to Edale and Castleton.

In Section D there will be the following communications :—A discussion on chromosomes and heredity (to be opened by Prof. E. W. MacBride), and a series of papers on material collected in or *en route* to Australia in connection with the visit of the association last year. Prof. Herdman will contribute notes on the plankton collected between Liverpool and Fremantle (*viâ* the Cape), Dr. J. H. Ashworth will give an account of larvæ of Lingula taken in the Red Sea and Indian Ocean, Prof. Dendy will give notes on his collecting in Australia, and Prof. Poulton will exhibit insects taken in Australia. Mr. Launcelot Harrison will give a paper on the relation of the phylogeny of the parasite to that of the host. He will advance the views that in the case of total obligate parasites, closely related parasites will be found to occur on phyletically connected hosts, and therefore the study of such parasites may give valuable indications as to the phylogeny of the host; for instance, the Mullophaga found on the New Zealand Apteryx indicate that this bird is a Ralline bird, and not a Ratite. Lieut.-Col. Lieper will give a demonstration upon his recent work on Bilharzia in Egypt, during the course of which he has been able to elucidate the life-history of this parasite of man. Other papers promised are :—Prof. F. J. Cole and N. B. Eales, materials for a graphic history of comparative anatomy; Prof. Hartog on the movements of chromosomes in cell-division; Prof. Hickson on the distribution of sea-pens; Dr. Dixey and Dr. Cameron on entomological subjects; Prof. Meek on the distribution of fish and (another paper) on the future of scientific literature in relation to the war; Dr. J. S. Thomson on the elasmobranch fore-brain; Dr. W. C. Mackenzie on the vermiform appendix in Monotremes and Marsupials; Dr. C. Powell White on the regeneration of the tail in lizards; F. W. Ash on secondary sex-characters.

The arrangements for Section E are :—Papers by A. R. Hinks on the map on the scale of 1 : 1,000,000; O. J. R. Howarth on geographical considerations arising out of the visit to Australia in 1914; Prof. J. W. Gregory on relations of the central lakes of Westralia; Dr. R. N. Rudmose Brown on the growth of cities in Australia; J. McFarlane on the Burrinjuck dam and the Yanco irrigation area; a joint discussion with Section C on the classification of land forms; a joint discussion with Section H on racial distribution in the Balkans (opened by Prof. G. Elliot Smith); papers by P. M. Roxby on north China and Korea; Dr. R. N. Rudmose Brown on Spitsbergen before the war; R. Curtis on the distribution of population in the district round Leek; T. Edwards on a rainfall map of Lancashire and Cheshire; Dr. F. Oswald on a recent visit to the Caucasus; J. Parry on lake movements as observed in Lake Vyrnwy, and one on afforestation, being continuation of the paper read at the Southport meeting in 1903.

Among the papers to be read in Section G are :—Prof. Asakawa and Prof. Petavel on an experimental investigation of the thermal efficiency of a gas engine; Prof. W. M. Thornton on the apparent specific heats in gaseous explosions; E. C. Mills on a unit gas-producer for steam boilers; A. A. Griffith on an investigation of the thermal conductivity of thin-air films; Prof. Batho on torsion stresses in framed structures and thin-walled prisms; A. Robertson on the strength of iron and steel struts; Dr. Eccles and A. J. Makower on electric oscillations in coupled circuits; Prof. G. W. O. Howe on the capacity of aerials of the umbrella type; Prof. Miles Walker on the eddy current losses in the end-plates of large turbo-generators; Prof. Walker will also describe some experiments to determine whether there exists mutual induction between masses; Prof. W. Morgan on the automobile and war; T. H. Brigg will describe a new method of attaching horses to vehicles.

In Section H the president's address will be followed by a discussion (to be opened by Prof. Elliot Smith) on the influence of ancient Egyptian civilisation on the world's culture; Prof. Flinders Petrie will deal with Egyptian jewelry, describing in particular the treasure of Lahun; Dr. Alan Gardiner will discuss the evidence pointing to a common parent for the Phenician, Greek, and Sabæan alphabets afforded by the inscriptions on strelæ, undecipherable as any form of Egyptian writing, discovered by Prof. Petrie at Sinai in 1905; Prof. Giuffrida-Ruggeri, of Naples, has forwarded a paper on the racial origins of the early Neolithic and copper-using peoples of Egypt, which will be presented and discussed by Prof. Elliot Smith, and Miss Margaret Murray, in a communication on royal marriage and matrilineal descent, and Mr. Hocart, in a paper on the quest for immortality, will be concerned largely with the Egyptian evidence. Racial distribution in the Balkans will form the subject of a discussion in joint session with Section E. Papers will be read by R. M. Dawkins on the Greek element in Asia Minor; and Dr. Rivers on analysis of ceremonial and descent in Ambrim. In physical anthropology Prof. Keith will present and discuss, at the request of the author, *une Application anthropologie à l'Art militaire*, by Prof. E. Manouvrier, of Paris, which deals with the desirability of classifying troops acording to certain anthropological characters; and Prof. Elliot Smith will exhibit the most ancient human remains from India. There will be a visit to the Roman fort at Ribchester, the exploration of which has been carried on under the auspices of Manchester University. The main features of the fort will be described by Prof. Haverfield, Prof. W. B. Anderson, who has been in charge of the excavations, and others.

In Section I it was hoped to have had a discussion on the physiological conditions necessary for the maximum efficiency of the factory worker, but the absence, owing to circumstances created by the war, of so many who could have spoken authoritatively on the subject has necessitated its deletion from the programme. Prof. B. Moore is giving a popular lecture during the meeting, in which he will have a good deal to say on the physiology of factory labour. Prof. Bayliss is to speak on the mode of action of urease; Dr. Edridge-Green on some fundamental facts of vision and colour vision; and Prof. B. Moore on the action of light on certain inorganic and organic substances. Some local contributions are kinematograph films by Dr. Graham Brown; the presence of copper in animal and vegetable tissues by Dr. C. Powell White; some laws of fat absorption, and the micro-chemical differentiation of tissue fats and lipoids, by Drs. Lamb and Holker. Dr. C. E. Lea is to give a demonstration of the detection of certain cardiac disorders by the electrocardiograph. Other contributors are Dr. Sarah M. Baker, on the liquid pressure theory of muscular contraction; Prof. W. H. Thompson on arginine and creatine formation, and on the effects of tetanisation on the creatinine and creatine of the muscles of the cat; Dr. John Tait on thrombokinase; Drs. Tait and Pringle on the elasticity of the strophanthinised heart; and Prof. P. T. Herring on the effect of thyroidectomy on the adrenin-content of the suprarenals.

In Section K a lecture is to be given by W. Lawrence Balls on cotton, and the following papers will be read:—Prof. F. O. Bower on the evolution of some ferns, in particular the Dipterids and the allies of the common bracken; Dr. D. H. Scott on the fossil plants of the genus Heterangium; Dr. Marie C. Stopes on the fossils of the Aptian (Greensand) period, including some of the oldest flowering plants of this country showing internal structure; Prof. Osborn on the morphology of *Selaginella uliginosa*, and his wife on some Australian fossils belonging to the genus Zygopteris; Dr. Ellis on fossil bacteria and fossil fungi; Dr. Sarah M. Baker on a new hypothesis regarding the ascent of sap in plants; Dr. Marion Delf on the effect of temperature on the permeability of protoplasm to water; Miss Prankerd on Statoliths; Prof. W. B. Bottomley on the formation of auximones from nitrogenous organic substances; Prof. Julius MacLeod on the expression by measurements of specific characters with special reference to the mosses; Dr. J. C. Willis on the evolution of the flora of Ceylon.

In Section L the following discussions may be expected:—On methods and content of history as a subject of school study; on military training in schools; on education of women in relation to their careers; on education and industry.

In Section M papers will be read by Prof. J. Hendrick on composition and uses of seaweed; by Prof. W. Somerville on accumulation of fertility in grass land; by D. Macpherson on types of hill grazings, their economic value and importance; and discussions will take place on probable effects of the war on the future of British agriculture, and the economics of milk production.

THE STUDY OF HEREDITY.

THE popularity of problems of genetics as subjects for research and discussion is well illustrated by the May number of the *American Naturalist* (vol. xlix., No. 581), every paper in which bears on one or other of such problems. Of especial interest is Prof. Jacques Loeb's article on the nature of the conditions which determine or prevent the entrance of the spermatozoon into the egg. It is well-known that in normal fertilisation, the entrance of the spermatozoon is followed by the formation of a membrane around the egg, so that the entrance of other spermatozoa is prevented. But, as Prof. Loeb has already recorded in his work on "Artificial Parthenogenesis and Fertilisation," sea-urchin eggs the development of which has been started by treatment with hypertonic sea-water can be afterwards fertilised, a spermatozoon being capable of entering a blastomere—at least up to the stage of the eighth cleavage—and inducing "a distinct and clear membrane formation" around it. This shows that the entrance of a male cell is not necessarily prevented by "the changes underlying development." But eggs by treatment with butyric acid can be induced to form a membrane. If this membrane remain unbroken subsequent fertilisation becomes impossible, though parthenogenetic segmentation may begin; if, however, the membrane be ruptured by shaking, a spermatozoon can enter and the egg undergoes normal development. Hence it may be inferred that the physical condition of the surface of the egg—howsoever modified—is the immediate determinant of the admission or exclusion of a spermatozoon. This view is supported by Loeb's experiments in cross-fertilisation, which show that the sea-urchin (Strongylocentrotus) egg admits the sperm of an echinoderm of another class only in a hyper-alkaline solution. On the other hand, eggs cannot be fertilised by sperms of their own species in sea-water containing an excess of neutral chlorides. From all these facts Loeb is inclined to draw the conclusion that the tension of the surface of the egg may explain the engulfment or exclusion of the spermatozoon. But it is obvious that in the case of normal fertilisation this surface-condition is "induced from within the egg by changes caused by the entrance of the spermatozoon"—a deduction made by biologists long before the study of "experimental embryology" had become fashionable.

In the same number of the *American Naturalist* Dr. Raymond Pearl continues his studies in heredity with reference to questions of practical breeding with a paper on Mendelian inheritance of fecundity in the domestic fowl." Large egg-yield, especially during the winter months, is shown by experiment to depend upon the presence of two Mendelian factors in the germ-cells, so linked with sex-determining characters that the female is heterozygous. Thus is confirmed the belief of some poultry-fanciers that the father is of greater importance than the mother for the establishment of a "good laying strain." In the *Biological Bulletin* (vol. xxviii., No. 3) Dr. M. R. Curtis describes a Rhode Island red hen with the terminal part of her oviduct aborted. Consequently the eggs—which were produced in the normal way—passed out into the body cavity and their food materials were absorbed by the bird's tissues without disturbance of the metabolism.

A recent number of our British *Journol of Genetics* (vol. iv., No. 4) contains a noteworthy paper, by Dr. H. Drinkwater, on the inheritance of brachydactyly in human families. The observations on this condition made by Dr. W. C. Farabee in North America, and by Dr. Drinkwater in this country are summarised in Mr. Bateson's book, "Mendel's Principles of Heredity," and brachydactyly has become a classical example of a simple Mendelian dominant-character. Dr. Drinkwater now describes a second family in England, and proves it to be a branch of the American stock studied by Dr. Farabee. The most important feature of the present study is found in the very beautiful series of radiographs of the brachydactylous hands and feet. The second phalanx is not really absent, but remains in a rudimentary condition, and becomes usually united to the base of the terminal phalanx.

Colour phenomena in animal and plant inheritance naturally continue to attract the attention of experimenters. A short paper on the "English" rabbit, by Prof. W. E. Castle and P. B. Hadley (Proc. Nat. Acad. Sci., vol. i.) is worthy of note. The "standard" coat in these rabbits is white with black muzzle, ears, and spots on back and flanks. Breeding experiments have shown that this "standard" coloration is really a mark of hybridity, for when mated together such rabbits yield a progeny half of which are either without the back and flank black markings or with these greatly exaggerated. The present paper describes how a "standard English" buck was mated with "Belgian hare" does, and how one of his dark-coated sons from this cross was afterwards mated to the same does; the result was that this latter begot distinctly darker offspring than his father, the "modal grades" being respectively 2·0 and 3·25. "Yet the father," write the authors, "contained only a single dose (one gamete) of English pattern, and the son derived his English pattern exclusively from this same source. Hence the English unit-character had changed quantitatively in transmission from father to son. This seems to us conclusive evidence against the idea of unit-character constancy or gametic purity."

Dr. L. J. Cole's paper on the inheritance of colour in pigeons (Rhode Island Agric. Exp. Station, Bulletin 158) was summarised in NATURE last year (vol. xciv.,

p. 213). The same subject has now been further investigated by Mr. D. Lloyd-Jones (*Journ. Experimental Zoology*, vol. xviii., No. 3) in a microscopical and chemical study of the feather-pigments. Red colour is due to red-brown pigment-granules which are present in the intermediate cells of the epidermis as well as in special pigment-cells. This pigment, if very finely divided, produces yellow. Black pigment under various conditions produces black, dun, blue, or silver.

Pigeons serve also as the subject of an inquiry into "Sex Ratios" by Drs. L. J. Cole and W. F. Kirkpatrick (Rhode Island Agric. Exp. Station, Bulletin 162). The normal ratio calculated from a large number of broods is 105 males to 100 females, and the death-rate is especially high for the first three days after hatching and at the age of about a fortnight. It is well known that the pigeon's normal brood consists of two eggs. In the recorded cases there were 284 bisexual broods to 302 unisexual; of the latter 149 consisted of two males and 153 of two females—a result indicating almost perfect equality. The death-rate of males and females in the bisexual broods is essentially equal. "A comparison of the numbers of each sex hatched from first and from second eggs respectively shows no tendency for the former to produce exclusively males and the latter females, but more males than females are hatched from both." The authors conclude that "sex in pigeons is determined according to the laws of chance"—in Mendelian terminology the individuals of one sex are heterozygous, and those of the other homozygous as regards the sex-determining factors.

G. H. C.

BIOMETRICS AND MAN.

IN part iv. of vol. x. of *Biometrika*, Mr. H. Waite publishes an interesting study, based on two thousand complete sets of finger-prints of adult males, part of a series in the biometric laboratory, University College, London. It appears that the various types of finger-print are not scattered at random over the fingers; certain types are more or less peculiar to certain fingers, and the appearance of one type is associated with that of another. In this respect certain fingers are more closely related to each other than to any third finger, and the distribution of this relationship is in general similar to that of the correlations of the bones of the same fingers. In the same number, Dr. Alice Lee discusses the influence of segregation on tuberculosis, a question to which much attention has been devoted of recent years. No method of measuring the extent of segregation is, however, found satisfactory, and the various methods used, for example, by Dr. Newsholme, lead, when examined by more stringent methods, to contradictory and inconclusive results. Whether there is any really substantial relation between the prevalence of phthisis and institutional segregation may remain an open question, but Dr. Lee is of opinion that no such relation has been demonstrated. Miss Elderton and Prof. Pearson similarly fail to find any evidence that isolation reduces the attack-rate from diphtheria; no appreciable influence on the attack-rate is found in certain data placed at their disposal by the medical officer of health for Coventry, though the death-rate may be lowered.

In the same journal Prof. Pearson, in collaboration with Miss Elderton, contributes an important memoir on further evidence of natural selection in man. The variate-difference correlation method is applied to the death-rates for males and for females in England and Wales from 1850 to 1908. The correlation between death-rates for successive years of life, over a long series of years, is high and positive. But the correlation of first differences is negative, and this negative correlation increases in intensity as higher and higher differences are taken, until fairly steady values are reached for the sixth differences, ranging round $-0{\cdot}7$. Thus for males the correlation of sixth differences in the first and second years of life is $-0{\cdot}688$, in the fourth and fifth years of life $-0{\cdot}695$. For females the corresponding figures are $-0{\cdot}719$ and $-0{\cdot}736$. The correlations in each case are taken between death-rates of those born in the same year. At an interval of two years the partial correlations are negative but much lower; at three and four years' interval the signs are irregular and the results inconclusive. To assert the existence of selection and measure its intensity, the authors remind their readers, must be distinguished from advocacy of a high infantile mortality as a factor of racial efficiency.

We can only briefly direct attention to two articles by Mr. R. A. Fisher on the frequency distribution of the correlation coefficient in samples from an indefinitely large population, and on the distribution of standard derivations of small samples.

REPORTS ON MINING INDUSTRIES.

TWO reports issued by the Canadian Department of Mines ("Peat, Lignite, and Coal," by B. F. Haanel; "Report on the Non-Metallic Minerals Used in the Canadian Manufacturing Industries," by Howells Frechette; Ottawa, 1914) are further examples of the sedulous care with which the Canadian Government is endeavouring to foster the industry of mining in the Dominion. The report upon peat, lignite, and coal deals exclusively with the application of these fuels to the generation of power-gas and to the recovery of by-products, the latter being chiefly ammoniacal salts. An elaborate study has been made of the various methods of dealing with peat in Europe, although, for some reason not easy to understand, Russian practice appears not to have been included, in spite of the fact that conditions in Russia resemble more closely those in Canada than do any of the other countries investigated. The first part of the report is taken up with a discussion of the various methods of producing peat fuel; it is interesting to note that the author has devoted a good deal of attention to the well-known Ekenberg process of wet carbonisation, and that his conclusions are decidedly unfavourable to the process. He points out that the most recent report on the subject by Lassen shows "that in continuous operation on a large scale, a moisture content below 70 per cent. in the pressed cake cannot be counted on," and dismisses the subject with the following statement:—

"Although large funds have been placed at the disposal of various investigators in order to enable them to demonstrate the economic value of the process, and although a private company has conducted elaborate experiments on a large scale, involving the expenditure of a large amount of money, not one ton of peat fuel has been manufactured on a commercial scale by means of this process."

The author's opinion of the Brune and Horst process for pressing out the water is equally unfavourable, nor is he greatly impressed by the possibilities of any of the methods of artificial drying, and sums up in favour of air-dried peat. He shows that under normal Canadian conditions peat can be utilised to advantage for the production of gas provided that it contains not more than 40 per cent. of moisture and that it can be obtained at a cost not exceeding 1.50 dollars (6*s*. 3*d*.) per ton of peat containing 30 per cent. of moisture. He holds that the recovery of ammonia is not likely to be profitable unless the nitrogen content exceeds 1½ per cent. calculated upon absolutely dry peat. Finally, he shows that under favourable conditions power can be generated from certain of these Canadian peat bogs at a cost equal to or below that at which it can be obtained by the utilisation of water-power. A little attention is also devoted to the question of the utilisation of the lignites of certain of the Western Provinces, where true bituminous coal is not obtainable locally, and it is shown that in certain circumstances it too can be employed profitably in the generation of gas.

The second report is intended to aid, not only the mining industry, but also the very large number of manufacturing industries that depend to a greater or lesser extent upon an adequate supply of raw materials in the shape of mineral products. The report deals with a very large number of miscellaneous minerals, of which asbestos, barytes, clay, lime, and sand are perhaps the most important, and it should be noted that such minerals as are used in Canadian manufactures but are not produced in Canada are referred to, as well as the minerals of domestic production. It is noteworthy that quite a considerable quantity of minerals is imported, although they could be produced in the Dominion, and one of the main objects of this report is to bring actual or possible producers and consumers into closer touch with one another. The object is an excellent one, and such reports as this should prove of the greatest value to both parties and should help towards that very desirable object, the industrial independence of this great Dominion.

The report of the Chief Inspector of Mines of the State of Mysore for the year 1913 has just been issued. Apart from the statistical portion, which shows that the value of the bullion produced during the year in question was 2,150,193*l*., a decrease of 0·37 per cent. from the previous year, the chief general interest in this report is to be found in a careful investigation of a shaft accident at the Mysore Gold Mine. It appears that the steel pin, which secured a driving clutch, that connected the engine shaft and the winding reel suddenly broke, allowing the cage, in which forty-two miners were travelling, to fall to the bottom of the shaft. An investigation was held into the cause of the fracture of this pin and into the reason why the powerful brake attached to the winding engine did not hold the reel, and the report of the committee of inquiry is now given. It cannot be said that the cause of the fracture is satisfactorily explained, but the insufficiency of the braking arrangements is very clearly demonstrated. Having regard to the fact that this brake is of the construction that is in general use on winding engines in all parts of the world, this report deserves the careful attention of all who have to do with winding from deep shafts by means of the powerful winding engines that are in general use in modern mines; in particular it may be noted that the brake appears to have complied fully with the provisions of our Coal Mines Act, and yet was found inadequate to prevent the very serious accident in question.

Another interesting section in this report deals with accidents due to "air blasts," which caused no fewer than thirty-one deaths during the year in question. These air-blasts consist in the sudden flying-off of huge masses of rock from the walls of stoped-out portions of the deposit, the action being extremely violent and suggesting that the rock is under some condition of great strain that suddenly relieves itself. The phenomenon is as yet but little understood, and all measures taken for combating this danger are still of a more or less tentative character.

TRYPANOSOMES CAUSING DISEASE IN MAN AND DOMESTIC ANIMALS IN CENTRAL AFRICA.[1]

THESE lectures are confined to a consideration of the trypanosomes causing disease in man and domestic animals in Central and Southern Africa. The conditions, however, which obtain on the east and west coasts of Africa between 20° N. and 30° S. latitude are much the same as those which are found in the central parts, and it is probable that the same trypanosome species are found throughout. So that in describing the species found in our own colonies it may be assumed that all the important pathological species found in Central Africa are being dealt with, although in other places they may be known by other names.

The central region—the tropical or equatorial—corresponds with the distribution of the tsetse-flies, and the trypanosomes causing disease in this region are carried from sick to healthy animals by various species of this genus of flies. In the north of Africa, outside the range of the tsetse-flies, two trypanosome diseases are found, one of the horse (dourine), and another of camels (surra), the former conveyed from sick to healthy horses by contagion, the latter almost certainly by large biting flies, the so-called horse-flies, or tabanidæ.

CLASSIFICATION OF THE AFRICAN TRYPANOSOMES.

The three characters mainly relied upon in this classification of trypanosomes are, in the first place, their morphology; secondly, their pathogenic action on animals; and, thirdly, their mode of development in the tsetse-flies. They may be divided into three groups, and these are set out in the following scheme :—

Group A. Trypanosoma Brucei Group.

1. *Trypanosoma brucei.*
2. *Trypanosoma gambiense.*
3. *Trypanosoma evansi.*
4. *Trypanosoma equiperdum.*

Group B. Trypanosoma Pecorum Group.

1. *Trypanosoma pecorum.*
2. *Trypanosoma simiae.*

Group C. Trypanosoma Vivax Group.

1. *Trypanosoma vivax.*
2. *Trypanosoma caprae.*
3. *Trypanosoma uniforme.*

These names probably represent most of the principal pathogenic trypanosomes discovered up to the present time in Africa. The northern species, *Trypanosoma evansi* and *T. equiperdum*, are placed in the first group, as they seem by morphology and their action on animals to belong there. Each group is distinguishable or separable by well-defined characters.

Group A. The Trypanosoma brucei Group.—The species forming this group (Fig. 1) are all more or less polymorphic, varying in size and shape from short and stumpy forms without free flagella to long and slender forms with free flagella. The cytoplasm contains numerous dark-staining granules. The micronucleus or kinetonucleus is small, and is situated as a rule some distance from the posterior extremity. The undulating membrane is well developed and thrown into bold folds.

[1] Abridged from the Croonian Lectures delivered before the Royal College of Physicians of London on June 17, 22, 24, and 29, by Sir David Bruce, C.B., F.R.S.

In regard to their action on animals, the members of this group may be said generally to affect many different species of animals—as, for example, man, horses, cattle, dogs, and most of the smaller experimental animals. The two Central African members of the group, *T. brucei* and *T. gambiense*, develop in the tsetse-flies in the same way. At first the development takes place in the intestine; afterwards the parasites pass into the salivary glands, by way probably of the proboscis, and there complete their development into infective forms. This is the only group in which the salivary glands are invaded. This group can be separated from the other groups by shape alone.

FIG. 1.—*Trypanosoma brucei* (Plimmer and Bradford) Zululand, 1913. ×about 700.

Group B. The Trypanosoma pecorum Group.—The trypanosomes are small and monomorphic. The cytoplasm is non-granular. The micronucleus is prominent, subterminal, and often seems to project beyond the margin. The undulating membrane is fairly well developed (Fig. 2).

The cycle of development in the tsetse-fly in Group B begins in the intestinal tract; afterwards the flagellates pass forward into the proboscis of the fly, and finally reach the salivary duct or hypopharynx, where they complete their development and become infective. The difference between Group A and Group B is that in the latter the salivary glands are never invaded. There are only two species at present included in this group—*T. pecorum* and *T. simiae*. The former gives rise to the most important trypanosome disease of cattle in Africa, while the latter is remarkable for the rapidity with which it kills the domestic pig.

FIG. 2.—*Trypanosoma pecorum*. ×about 700.

Group C. The Trypanosoma vivax Group.—The species making up this group (Fig. 3) are monomorphic, and remarkable for the extreme rapidity of their movements. The posterior extremity is enlarged. The cytoplasm is clear and hyaline. The micronucleus is large and terminal, and the undulating membrane is little developed and simple. This species only affects horses, cattle, goats, and sheep. Monkeys, dogs, rabbits, guinea-pigs, and rats are refractory.

The cycle of development in Group C differs from that in Groups A and B in that it takes place at first only in the labial cavity of the proboscis, and later in the salivary duct or hypopharynx. No part of the cycle takes place in the intestinal tract or in the salivary glands.

These three groups are well marked, and it is fairly easy by microscopic examination alone to name what group a trypanosome belongs to, when seen in the blood of the vertebrate host or even in the tsetse-fly.

DESCRIPTION OF THE TSETSE-FLIES.

A description of *Glossina morsitans* and *Glossina palpalis* is given, with a figure illustrating the mouth parts of a tsetse-fly.

It is important to understand the structure of the proboscis, as this plays an important part in the development of Groups B and C. In the transverse section the parts are seen in position, the labrum and labium joined together form a tube through which the blood is drawn in the act of sucking, and known as the labial cavity; and the delicate terminal duct of the salivary glands or hypopharynx lying in the hollow of the labium, and opening near the tip of the proboscis. The salivary glands are long convoluted organs lying chiefly in the abdominal segment of the fly.

FIG. 3.—*Trypanosoma vivax* (Ziemann). ×about 700.

It was stated that probably all the tsetse-flies are capable of acting as carriers of all the pathogenic trypanosomes, at least in laboratory experiments. What makes one species of fly the especial carrier of a particular trypanosome is probably bound up in the natural history, the habits, and distribution of the fly.

It was shown that the two principal groups of tsetse-flies—the *G. morsitans* group and the *G. palpalis* group—differ from each other in well-marked characters, the former living in wild, unpopulated districts and trusting to the wild game for their food, the latter along rivers and lakes which are usually thickly populated, and trusting to man for a food supply, or in his absence living on the large reptiles, birds, and antelopes which frequent these places.

THE TRYPANOSOMES CAUSING DISEASE IN MAN AND DOMESTIC ANIMALS IN CENTRAL AFRICA.

Group A. Trypanosoma brucei Group.

(1) *T. brucei*, the Nagana Parasite.—This was the first pathogenic trypanosome discovered in Central or South Africa. It was found in Zululand in 1894 in the blood of native cattle suffering from Nagana. The parasite was sent in the living condition to the

Royal Society in 1896, and at that time found its way into many laboratories, and much of the earlier work on trypanosomes was founded on it. The parasite causing the Rhodesian and Nyasaland form of sleeping sickness, and which had been named *T. rhodesiense*, is considered to be identical with *T. brucei*. Various strains, Zululand, 1894 and 1913, Nyasaland and Uganda, are compared, and the conclusion come to that they are identical in morphology.

SUSCEPTIBILITY OF ANIMALS TO *T. brucei*.

Many mammals, including man, horses, mules, donkeys, oxen, goats, sheep, monkeys, dogs, and many others, are attacked by this parasite. Birds and the cold-blooded vertebrates, such as crocodiles, lizards, and frogs, are quite unaffected by it. A single trypanosome seems to be just as efficacious in setting up infection as a million, and it does not seem to matter whether the kind of trypanosome injected is one of the long and slender forms or one of the short and stumpy.

Table I.—Giving (a) *the Average Duration in Days of the Disease in Various Strains of* T. brucei.

Strain	Man	Horse	Oxen	Goats and sheep	Monkeys	Dogs	Rabbits	Guinea-pigs	Rats
Human	90	—	134	42	26	34	28	67	30
Wild game	—	—	—	46	38	41	—	—	32
Wild *Glossina morsitans*	—	—	Recovered	54	38	29	47	81	26
Zululand, 1913	—	38	310	77	29	18	33	44	27
(b) *The Number of Animals Employed.*									
Human	?	—	1	?	20	25	7	15	21
Wild game	—	—	—	5	9	13	—	—	6
Wild *Glossina morsitans*	—	—	2	16	14	25	3	10	19
Zululand, 1913	—	3	1	7	8	17	8	10	23

Table I. gives the average duration in days of the disease caused by various strains of this trypanosome, also the number of animals employed. From this it will be seen that this disease runs a fairly rapid course in man, killing him as a rule in three or four months. This, as we shall see, is in marked contrast to the much more chronic course of the Congo sleeping sickness caused by *T. gambiense*. In horses, donkeys, and mules nagana runs its course on an average of thirty-eight days. No opportunity of studying the disease in horses occurred in Uganda or Nyasaland, as horses are very seldom seen in these countries. In the ox the disease is chronic and a certain proportion recover. In the other animals it may be said broadly that the disease runs a fairly similar course, and that little or no difference in the virulence is seen between the different strains.

Nagana is, as a rule, a fatal disease. With the exception of the oxen, almost all the other animals die. Out of 318 employed in these experiments only three recovered.

From its action on animals, then, just as from its morphology, it is apparent that *T. brucei* as it occurs in Zululand differs in no way from the Nyasaland strain called by Stephens and Fantham *T. rhodesiense*.

THE INFECTIVITY OF WILD TSETSE-FLIES (*G. morsitans*).

The tsetse-flies in Nyasaland were examined in order to find out how many of them were naturally infected. There were fifty-six experiments, and 10,081 tsetse-flies (*G. morsitans*) were employed. In the fifty-six experiments *T. brucei* was found twenty times (35·7 per cent.). Nine monkeys, fourteen dogs, and eleven goats were infected. This gives a proportion of 1 in 500, or 2 flies per 1000 caught in the sleeping sickness area, Nyasaland, infective with nagana. This is only allowing one infective fly to each series of flies fed on the experimental animals, and is therefore the irreducible minimum.

TRYPANOSOMES FOUND IN THE BLOOD OF WILD ANIMALS LIVING IN THE SLEEPING-SICKNESS AREA, NYASALAND.

When an animal was shot a small quantity of its blood was taken in a sterilised bottle containing citrate of potash to prevent coagulation. Smear preparations were made at the same time. As the animals were often shot thirty or forty miles away from the camp, a motor-cycle was used to get the blood up the hill as quickly as possible. When the blood arrived at the laboratory it was at once injected into a goat, a monkey, and a dog. In this way 180 specimens of blood of wild game living in the fly area were examined, and fifty-seven were found to harbour pathogenic trypanosomes (32 per cent.).

This is, however, probably much below the actual percentage. A wild animal is only examined once, and that often under unfavourable conditions. If it were possible to examine the same animal several times it is probable that many more would be found infected. The parasites come and go in the blood; one day they may be present, the next day absent. The big game live in the "Fly Country" among swarms of infected flies, and are constantly liable to infection and re-infection.

The following table (Table II.) represents the number of times *T. brucei* was found among the 180 wild animals examined, and the species of game which harboured it.

Table II.—This Represents the Number of Times T. brucei *was Found Among the* 180 *Wild Animals Examined and the Species of Game which Harboured it.*

Species of animal	Number examined	Number infected with *T. brucei*	Species of animal	Number examined	Number infected with *T. brucei*
Eland ...	10	0	Duiker..	7	1
Sable ...	5	0	Buffalo..	9	0
Waterbuck	13	3	Lion ...	1	0
Koodoo ...	3	0	Hyæna..	3	0
Bushbuck...	10	0	Elephant	2	0
Hartebeeste	35	5	Warthog	33	1
Reedbuck...	19	3	Wild cat	3	0
Oribi ...	26	1	Porcupine	1	0

From this it will be seen that fourteen animals among the 180 harboured the nagana parasite (7·8 per cent.), and that the waterbuck, hartebeeste, reedbuck, and duiker seem to be the most dangerous neighbours to man. Twenty-three per cent. of the waterbuck, 14 per cent. of the hartebeestes, 16 per cent. of the reedbuck, and 14 per cent. of the duiker had *T. brucei* in their blood. If, then, the contention that this parasite found in the wild game is the cause of Nyasaland sleeping-sickness be proved to be true, then it is abundantly obvious how dangerous these wild animals are to man; and it must be borne in mind that in this Nyasaland fly area *T. brucei* is only one of the pathogenic species of trypanosome found in the wild game. Other three species pathogenic to the domestic animals are also found, *T. pecorum*, *T. simiae*, and *T. caprae*; *T. pecorum* in 14·4 per cent., *T. simiae* 1·7 per cent., and *T. caprae* in 11·1 per cent. of the wild game examined. It is self-evident that these wild animals should not be allowed to live in "Fly Country," where they constitute a standing danger to the native inhabitants and the domestic animals. It would be as reasonable to allow mad dogs to live and be protected by law in our English towns and villages. Not only should all game laws restricting their destruction in "Fly Country" be removed, but active measures should be taken for their early and complete blotting out. It must be strictly borne in mind that this only refers to wild animals living in "fly" areas. No pathogenic trypanosomes have up to the present been found by the Commission in the blood of animals living in fly-free areas.

(2) *T. gambiense*, the Parasite of Congo Sleeping-Sickness.—*T. gambiense* (Fig. 4) is very similar in size and shape to *T. brucei*, but it would appear to be possible to distinguish them by the presence of the blunt-ended, posterior-nucleated forms which are so common in the blood of animals infected by the nagana parasite and quite absent in animals infected by the other. But as these posterior-nucleated forms are absent or scarce in the blood of man, this method of diagnosis requires the inoculation of experimental animals and the study of many preparations of their blood. It would appear to be impossible at present to distinguish between the two species by the microscopical examination of preparations made from the blood of man alone.

SUSCEPTIBILITY OF ANIMALS TO *T. gambiense*.

A marked difference exists between *T. gambiense* and *T. brucei* in regard to their virulence towards animals.

FIG. 4.—*Trypanosoma gambiense* (Dutton). Tanganyika, 1913. ×about 700.

It is almost impossible at first to give this disease to goats, monkeys, dogs, and guinea-pigs. The rat is the animal which is least refractory.

TABLE III.—*Showing the Average Duration in Days of the Disease caused by* T. gambiense, *Tanganyika, compared with that caused by* T. brucei, *Zululand.*

	Monkey	Dog	Guinea-pig	White rat
T. gambiense ...	159	96	264	137
T. brucei ...	26	34	67	30

The disease in animals caused by *T. gambiense* is thus much more chronic than that caused by *T. brucei*, and this character, combined with the morphology already described, affords the surest and safest means of separating these species.

G. palpalis THE CARRIER OF *T. gambiense*. INFECTIVITY OF WILD *G. palpalis*.

In 1903 at Entebbe, the Government cantonment, the tsetse-flies had plenty of opportunity of becoming infected, since they were caught in the vicinity of the hut-tax labourers' camp. These men came in thousands to Entebbe to work for Government for one month in lieu of paying hut-tax. They lived in rudely-built grass huts near the lake shore, and on examination of their blood some 30 per cent. of them were found to harbour the parasite. In 1903, while these highly-infected labourers were living on the lake shore, the proportion of infective flies was found to be as high as 11·2 per 1000. The Government removed the hut-tax labourers from the vicinity of the lake, which became deserted, and a year afterwards the proportion of infected flies fell to 1·2 per 1000. When the Commission returned to Uganda in 1908 and took up camp at Mpumu at the north end of Lake Victoria we found the lake-shore flies in the vicinity still infective, although the population had been removed early that year. The examination of 7200 flies gave a proportion of 1·8 per 1000. But we had given the Government to understand that as soon as the natives were removed the flies would become harmless. It was therefore important to find out how long the lake-shore flies remained infective, and why they remained infective. For this purpose they were examined every year until 1912.

TABLE IV.—*Showing the Results of Yearly Examinations of wild* G. palpalis *from* 1903 *to* 1912 *inclusive.*

Year.	Locality	Number of flies examined.	Number of flies infective	Proportion of infective flies per 1000	Remarks.
1903	Entebbe.	?	?	11·2	—
1904	,,	?	?	1·2	—
1908	Mpumu.	7,200	11	1·8	1 in 654
1909	,,	18,691	7	0·4	1 in 2670
1910	,,	27,179	4	0·14	1 in 6795
1911	,,	23,899	1	0·04	1 in 23899
1912	,,	28,279	4	0·14	1 in 7070

From this it will be seen that although there had been a steady decrease in the proportion of infective flies, a few remained, and these showed no sign of disappearing. The mistake made by the Commission was first in believing that the transmission of the *T. gambiense* was mechanical, and that a fly lost its power of infection within three days after feeding on an infected animal; and, secondly, in believing that man was the sole reservoir of the virus. It was found that a fly may remain infective for several months, and that man is by no means the only source of the virus.

THE CYCLE OF DEVELOPMENT OF *T. gambiense* IN *G. palpalis*.

This prolonged infectivity which some flies possess is due to the fact that in these the trypanosomes do not die off, but proceed to further multiplication. It was shown that a very small proportion of flies which feed on an infected animal show this cycle of development. In one series of experiments, forty-two in number, only one fly in 212 (0·5 per cent.) became infective. An average of thirty-six days is required to complete the cycle. The long account given may be summarised as follows.

Trypanosomes taken into the alimentary canal of tsetse-flies retain their shape and infectivity for some eighteen hours. They then degenerate and lose their power of infection, and as a rule have disappeared altogether from the majority of the flies by the fifth or sixth day. In a small percentage of flies, male as well as female, the trypanosomes maintain their position, they continue to multiply, and in a short time swarm in the alimentary canal of the fly. These multiplication forms bear little or no resemblance to the original trypanosomes. After some twenty or thirty days the developing flagellates find their way into the salivary glands, resume their original blood form, and regain their infectivity.

THE RESERVOIR OF *T. gambiense* (CONGO SLEEPING-SICKNESS).

Besides man, who is probably the most important reservoir of the virus, native cattle and the antelope living on the lake-shore in Uganda were found to harbour the parasites in their blood.

The prophecy that the fly would become harmless shortly after the natives were removed from the lake shore has unfortunately proved wrong, and before the islands are repopulated some other measure will have to be taken to get rid of the fly danger.

GROUP B.—THE *T. pecorum* GROUP.

I.—*T. pecorum.*

The first of this small group, which only consists of two species, is *T. pecorum*. It is probably the most important trypanosome disease of domestic animals in Central Africa.

Morphology.

Fig. 2 shows the general appearance of the trypanosome. It is the smallest of all the African pathogenic trypanosomes, varying from 9 to 18 microns in length, with an average of 14 microns.

Animals Susceptible to T. pecorum.

In regard to the animals attacked by this trypanosome. This is essentially a disease of the herds: horses, donkeys, oxen, goats, sheep, and pigs, all fall victims.

TABLE V.—*The Average Duration of Life, in Days, of Various Animals Infected by* T. pecorum.

—	Donkey	Cattle	Goat	Pig	Monkey	Dog	Guinea-pig	White rat
Average duration in days	87?	121?	55	21	129	48	41	33
Number of animals employed ...	1	4	59	1	11	57	5	10

The Percentages of Recoveries in Various Animals from T. pecorum *Infection.*

Percentages	80	35	12	0	0	1	0	0
Number of animals employed ...	5	17	70	1	11	63	5	10

This trypanosome does not seem to be very fatal to horses, mules, or donkeys. In Nyasaland there was no opportunity of testing it on horses, but out of five donkeys four recovered. Two-thirds of the cattle, and seven-eighths of the goats, succumbed.

THE CARRIER OF *T. pecorum.*

The chief carrier of *T. pecorum* is *G. morsitans*. In Nyasaland, this parasite was the commonest of the trypanosomes with which *G. morsitans* was infected. There were fifty-six experiments, and 10,081 tsetse-flies (*G. morsitans*) were employed. In the fifty-six experiments *T. pecorum* was found forty-six times, more than twice as often as *T. brucei*. Nine monkeys, thirty-four dogs, and thirty-five goats were infected. This gives a proportion of 4·6 per 1000 flies infected with *T. pecorum*.

THE CYCLE OF DEVELOPMENT OF *T. pecorum* IN *G. morsitans.*

This trypanosome belongs to Group B, in which development takes place first in the gut and then passes forward into the labial cavity of the proboscis, and finally reaches the salivary duct or hypopharynx where the trypanosomes revert to the original blood form and become infective. There is no infection of the salivary glands.

THE TYPE OF TRYPANOSOMES FOUND IN THE INFECTED FLIES.

Fig. 5 represents the developmental forms of *T. pecorum* found in labial cavity of *G. morsitans*. The first seven figures represent early forms in the labial cavity. These were seen adhering singly by their flagella to the labrum.

The next group contains the ordinary forms found clinging by their flagellar ends to the labrum. It will be seen that they have assumed the crithidial stage, a stage which seems to be a *sine quâ non* in the final stages of the cycle of development of all the pathogenic trypanosomes, and the interpretation of which is still obscure. The small blood forms are from the hypopharynx of dead infective flies. They represent the final stage in the cycle of development and are the only infective forms. On the same figure are seen drawings of the labrum and hypopharynx of a fly infected with this trypanosome. While the labial cavity is seen to contain clusters of large ribbon-like trypanosomes, the hypopharynx is swarming with the

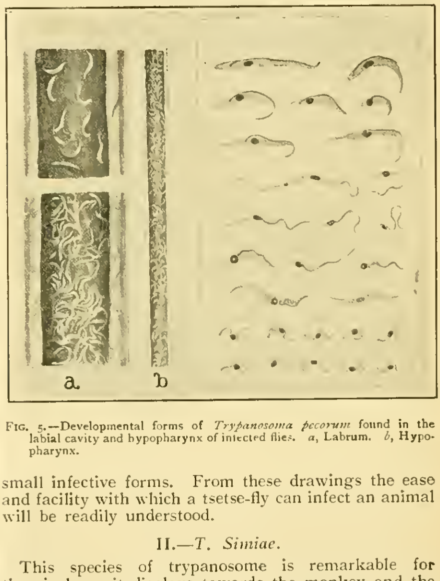

FIG. 5.—Developmental forms of *Trypanosoma pecorum* found in the labial cavity and hypopharynx of infected flies. *a*, Labrum. *b*, Hypopharynx.

small infective forms. From these drawings the ease and facility with which a tsetse-fly can infect an animal will be readily understood.

II.—*T. Simiae.*

This species of trypanosome is remarkable for the virulence it displays towards the monkey and the domestic pig, killing these animals in an incredibly short period of time, whereas it is harmless to oxen, antelope, dogs, and the smaller experimental animals. Curiously enough it affects goats and sheep, although oxen and antelope escape.

In the whole range of the trypanosome diseases of animals there is surely nothing so striking as the rapidly fatal action of *T. simiae* on the domestic pig. In nine experiments the average duration was only 5·3 days. This not from the time of the appearance of the trypanosome in the blood, but from the date of the infection. Further, this rapid action is not the result of an exaltation of virulence by numerous passages through the pig, but natural to the trypanosome.

Another interesting point in regard to this species is that, so far as is known, the warthog is the only animal among the wild game which harbours it. It is probable that it will also be found in the blood of the bush-pig, but that has not been done yet.

GROUP C.—THE *T. vivax* GROUP.

The three species forming this group have a strong family resemblance, and but for size might almost be included in one species.

I.—*T. vivax.*

This is the cause of one of the most important cattle diseases in Uganda. We did not meet with it in Nyasaland, where its place seems to be taken by *T. caprae.* It is, however, widely distributed in Central Africa. It has been reported from Senegal and the Sudan in the north to Rhodesia in the south. It is easily recognised on account of its extreme activity during life, its characteristic morphology in stained specimens, and the fact that it only affects horses, cattle, goats, and sheep, while monkeys, dogs, rabbits, guinea-pigs, rats, and mice are refractory. In Uganda the tsetse-flies on the lake shore were found to be infected with it, and it was also found in the blood of a bushbuck shot at the same place at which the flies were collected (see above and Fig. 3).

II.—*T. uniforme.*

This trypanosome resembles *T. vivax* very closely except that it is smaller. Up to the present it has only been found in Uganda. Its carrier there is *G.*

FIG. 6.—*Trypanosoma simiæ.* ×about 700.

palpalis, and its reservoir the wild game on the lake shore.

III.—*T. Caprae,*

This species has only been reported up to the present from Lake Tanganyika and Nyasaland. It, like the other two species belonging to this group, only affects cattle, sheep, and goats. Monkeys, dogs, and smaller experimental animals are immune.

CONCLUSION.

This concludes the Croonian Lectures on the trypanosomes causing disease in man and domestic animals in Central Africa. These lectures deal with but a small part of the subject, which has in the course of the last twenty years grown to huge proportions. Nothing has been said about medicinal treatment, and even measures of prevention have been left a good deal to the imagination. Taking a look back over the whole field the outstanding features may be said to be, first, that some order is beginning to reign in what was lately chaos in regard to the classification of the pathogenic trypanosomes. They may all now be referred to three groups and nine species.

In regard to the transference of the virus from sick to healthy animals by the fly, this has been made clearer and easier of comprehension by the discovery of the part which the salivary glands and hypopharynx play in the various modes of development which the trypanosomes undergo in the fly. It results that it would almost appear impossible for an infective fly to pierce even momentarily the skin of a healthy susceptible animal without causing infection.

Another important feature is the proof brought forward that *T. brucei* and *T. rhodesiense* are the same.

Finally, in regard to the prevention of these trypanosome diseases of man and domestic animals. We have seen that the wild game in the fly country is heavily infected. It is impossible to doubt that they are the reservoir and source of many of these diseases. There can be little doubt that if the wild game were driven out of the fly country trypanosome diseases such as those caused by *T. brucei* and *T. pecorum* would disappear.

In regard to the measures of prevention against the most important of all the trypanosome diseases—Congo sleeping-sickness—it has been shown by experience that the removal of the natives from the fly area is a simple and efficacious way of stopping an epidemic. In these sparsely inhabited countries, where spare land and food are easily obtained, there is, as a rule, no difficulty in effecting this migration. If it is desired to go a step further and render the sleeping-sickness area habitable, then clearing and cultivation must be resorted to. By these means, in all probability, *G. palpalis* will be driven away, and with it the disease.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. G. EARLE has been appointed to the chair of physiology in the University of Hong-kong.

DR. J. A. MENZIES has been appointed professor of physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne.

IN the prospectus of the University College of North Wales a reference to "Aeroplane and Other Researches" occurs in the schemes of study of the department of applied mathematics. In view of the important part played by aeroplanes in the present war, we hope that Prof. Bryan will make every effort to enlist the services of his pupils in the solution of the many unsolved problems which he has enumerated, and that he will encourage them to take up this work in preference to studies of a more examinational character. We understand from Prof. Bryan that he would be glad to secure the assistance of students from other universities possessing the necessary training in applied mathematics who are able and willing to enter the college at Bangor for a post-graduate course of research in the subjects in question.

THE prospectus of the University courses in the Municipal School of Technology, Manchester, for the session 1915–16, which is now available, serves admirably to give the inquiring student an excellent idea of the resources and equipment of this great technical college. It will be remembered that a faculty of technology in the University of Manchester was established in 1905, with the principal of the School of Technology as dean of the faculty and with the heads of the mechanical and electrical engineering, applied chemistry, and architecture departments of the School of Technology as professors of the University.

The dean and these professors are members of the University Senate. The University courses provided by the school lead to the degrees of Bachelor and Master of Technical Science. These courses are controlled by the Senate of the University, through the board of the faculty of technology, which is composed of the heads of departments in the School of Technology together with certain other professors and lecturers in the University. A new characteristic of the present issue of the prospectus is the excellent summary running to some ten pages of approved courses which students proceeding to degrees in technical science, or certificates in technology, are recommended to follow. The account of the equipment of the laboratories, for which the school is justly renowned, gives particulars which serve as an index of the lavish and judicious expenditure incurred to make the college thoroughly complete and modern.

Some of our universities have already taken steps to deal justly with the many young men who have broken their academical work by joining the Army. The subject is dealt with at length in *Engineering* for August 6. But few of these young men will be able again to take up the threads of their studies when peace is proclaimed. They will have been face to face with actualities of most serious import, and will never again be able to resume the docile and attentive attitude which befits the student. It is most earnestly to be hoped that before peace is declared the whole of the academic and professional bodies of this country will come to some definite decision as to what is to be their attitude to the young men who are faced with the possibility of their careers being broken irretrievably. The matter is not simple, as the claims both of the public and of the young men have to be considered; the former expect that diplomas shall not be given to men lacking in the necessary attainments; it would be outrageous to the latter if the future prizes in life were allotted to those who stayed at home. *Engineering* suggests that the kind of knowledge which might be expected reasonably from candidates who have served in the Army is that which an ordinary candidate has retained three years after taking his diploma. In that time all tricks for examination purposes have disappeared, leaving only that knowledge which the man felt was really necessary for his profession. We should like to add to the case which is presented very ably by our contemporary, that it is extremely desirable that all our universities and colleges come to a common understanding, so that there shall be equality of treatment for all the candidates on retiring from the Army.

SOCIETIES AND ACADEMIES.

Edinburgh.

Royal Society, July 5.—Sir E. A. Schäfer, vice-president, in the chair.—Sir William **Turner**: A contribution to the craniology of the people of Scotland: Part ii., prehistoric, descriptive, and ethnographical. Judging from the size and general plan of the skull of the prehistoric inhabitants of Scotland, he found nothing to show that these very remote ancestors were not people of great brain-power.—W. **Evans**: Mallophaga and Ixodidæ, Ectoparasites of birds from the *Scotia* collections (Scottish National Antarctic Expedition). Interesting examples were recorded of the same species of parasite infesting closely allied species of birds.—Dr. J. R. **Milne**: Mathematical theory of the harmonic synthetiser: part ii. Nine years ago the author described an instrument for drawing the curve which is the sum of a number of simple harmonic curves. The apparatus makes use of Kelvin's summation wire and an approximate method of obtaining harmonic motions which was rejected by him as insufficiently accurate. It was shown, however, in the previous paper that if the various parts be properly proportioned, the error can be made very small. The more complete mathematical discussion in the present paper shows how it may be reduced to negligible dimensions.—Prof. C. R. **Marshall** and Miss Elizabeth **Gilchrist**: The interaction of methylene iodide and silver nitrate.—James W. **Munro**: The structure and life-history of *Bracon hylobii*, a study in parasitism. The *Hylobius abietis* was the most dangerous insect enemy to forestry in Scotland. One way of fighting it was by the breeding and setting free of a parasitic enemy. Such a parasite is *Bracon hylobii*.—Miss Augusta **Lamont**: The lateral sense organs of Elasmobranchs; the ampullary canals of the genus Raia.

New South Wales.

Linnean Society, May 26.—Mr. A. G. Hamilton, president, in the chair.—W. N. **Benson**: The geology and petrology of the great serpentine-belt of New South Wales. Part iv.—The dolerites, spilites, and keratophyres of the Nundle district. This paper is a detailed account of the Middle Devonian igneous rocks, which were briefly discussed in earlier parts of this series. It is shown that the rocks are intrusive, whenever clear evidence of their *mise-en-place* is obtainable, even though pillow-structure is well developed, a feature usually characteristic of flows. A remarkable series of magnetite-albite rocks have been discovered among the keratophyres. They find their closest analogy among the igneous rocks accompanying the iron-ores of Lapland.—Dr. A. J. **Turner**: Further notes on the Lepidoptera of Ebor Scrub, N.S.W. Two later visits in February, 1915, resulted in the acquisition of specimens of thirty-one species, of which only seven were obtained in 1914. Thirteen of the twenty-four additional species are known from other localities; nine are described as new; and two remain undetermined. Two species, previously undetermined, are described as new from more complete material.—F. H. **Taylor**: Contributions to a knowledge of Australian Culicidæ. No. II. Five species referable to the genera Stegomyia, Neomacleaya, Culicada, and Culex (two) are described as new. The males of two species, previously unknown, are also described.—Dr. R. **Greig-Smith**: A new gum-levan-forming Bacterium. The hitherto described bacteria capable of forming gum-levan from saccharose, are two in number. A third has been isolated from the tissues of a seedling of *Eucalyptus hemiphloia*. It differs from *Bac. levaniformans* in forming no spores; and from *Bac. eucalypti* in its power of fermenting dextrose, saccharose, and lactose, with production of acid and gas.—E. A. **Briggs**: Hydroids from New South Wales. *Sertularella longitheca*, Bale, var. *robusta*, Ritchie (fam. Sertularidæ), described from sterile specimens dredged off the coast of New South Wales, is now shown, from the examination of colonies bearing gonangia, not to be a variety of *S. longitheca*, but to be entitled to specific rank.—Dr. Th. **Mortensen**: Preliminary note on the remarkable, shortened development of an Australian sea-urchin (*Toxocidaris erythrogrammus*). The ova are large, opaque, and full of yolk, and float on the surface of the water. Cleavage is total and regular at first. The gastrula is free-swimming, the aboral end being turned upwards, and containing most of the yolk. The postoral processes are represented only by a rudimentary swelling, and there is no sign of a Pluteus-stage; nor, apparently, is there any trace of a larval skeleton. The whole animal is ciliated, but the cilia are not collected into bands. The young sea-urchin develops on one side of the embryo, near the mouth. The aboral part serves as a food-reservoir, and becomes finally quite overgrown and enclosed within the urchin's body. The young animal may sink to the bottom or remain swimming at the surface.

BOOKS RECEIVED.

Revision Papers in Algebra. By W. G. Borchardt. Pp. vi+152+xxxix. (London: Rivingtons.) 2s.

Stories of Exploration and Discovery. By A. B. Archer. Pp. viii+198. (Cambridge; At the University Press.) 2s. 6d. net.

The North-West and North-East Passages, 1576–1611. Edited by P. F. Alexander. Pp. xix+211. (Cambridge: At the University Press.) 2s. 6d. net.

Post-Mortem Methods. By Prof. J. M. Beattie. Pp. viii+231. (Cambridge: At the University Press.) 10s. 6d. net.

The Study of Plants. By Dr. T. W. Woodhead. Pp. 440. (Oxford: At the Clarendon Press.) 5s. 6d.

Publications of West Hendon House Observatory, Sunderland. No. iv., Meteorological Observations chiefly at Sunderland. By T. W. Backhouse. Pp. v+188. (Sunderland: Hills and Co.)

The Sacred Chank of India. By J. Hornell. Pp. viii+181+18 plates. (Madras: Government Press.)

Experimental Harmonic Motion. By Dr. G. F. C. Searle. Pp. x+92. (Cambridge: At the University Press.) 4s. 6d. net.

Annals of the Cape Observatory. Vol. xii., part 1: Determination of the Mass of Jupiter and Elements of the Orbits of its Satellites, from Observations made with the Cape Heliometer. By Sir D. Gill and W. H. Finlay; reduced and discussed by Prof. W. de Sitter. Pp. 173. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 6s.

Cape Astrographic Zones. Vol. ii.: Catalogue of Rectangular Co-ordinates and Diameters of Star Images, derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the direction of Sir D. Gill. Completed and prepared for press under the supervision of S. S. Hough. Zone—42°. Pp. xxxviii+499. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 20s.

Results of Meridian Observations of Stars made at the Royal Observatory, Cape of Good Hope, in the years 1905 to 1908, under the direction of Sir D. Gill and S. S. Hough. Pp. 255+127. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 30s.

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. vii, pp. 128; Contributions to Embryology, Vol. i., No. 1, pp. 103 and 11 plates; Vol. ii., Nos. 2, 3, 4, 5, 6, pp. 5–108; The Permo-Carboniferous Red Beds of North America and their Vertebrate Fauna. By Prof. E. C. Case. Pp. iii+176+24 plates. (Washington: Carnegie Institution.)

Wireless Time Signals. Issued by the Paris Bureau of Longitudes. Authorised translation. Pp. vii+133. (London: E. and F. N. Spon, Ltd.) 3s. 6d. net.

Light and Colour Theories and their Relation to Light and Colour Standardisation. By J. W. Lovibond. Pp. xii+90+plates. London: E. and F. N. Spon, Ltd.) 6s. net.

Mineral Resources of Minas Geraes (Brazil). By A. F. Calvert. Pp. 100+127 plates. (London: E. and F. N. Spon, Ltd.) 6s. net.

The World's Supply of Potash. Pp. 47. (London: The Imperial Institute.) 1s.

Prof. Edward Forbes' Centenary, 1915. Pp. 45. (London: The Manx Society.) 1s.

The Callendar Steam Tables. By Prof. H. L. Callendar. Pp. 40, with Steam Diagram in Pocket. (London: E. Arnold.) 3s. net.

The War and After. By Sir Oliver Lodge. Pp. xiii+235. (London: Methuen and Co., Ltd.) 1s. net.

A School Flora for the Use of Elementary Botanical Classes. By Dr. W. M. Watts. New edition. Pp. viii+208. (London: Longmans and Co.) 3s. 6d.

Health in the Camp. By Prof. H. R. Kenwood. Pp. 58. (London: H. K. Lewis and Co., Ltd.) 3d. net.

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THURSDAY, AUGUST 19, 1915.

THE BOOK OF FRANCE.

The Book of France. In Aid of the French Parliamentary Committee's Fund for the Relief of the Invaded Departments. Edited by Winifred Stephens. Pp. xvi + 272. (London: Macmillan and Co., Ltd.; Paris: E. Champion, 1915.) 5*s.* net.

THE catastrophe which has overtaken the world, and threatens to shake the very foundations of society, is destined to create a literature which has no parallel in history. This is inevitable, for—such is the irony of the situation—the nations that are engaged in this stupendous struggle are the most cultured and most civilised peoples on this earth, and to them the production and consumption of literary food is scarcely less necessary than the production and consumption of their daily bread. Appetite grows by what it feeds upon. Already the output of war books has reached a colossal proportion, and imagination boggles at the attempt to estimate the dimensions to which it will ultimately attain. Many of these books are, of course, ephemeral productions, created to satisfy a passing but no less insistent demand—books which are no books, as Charles Lamb would say—and in no true sense literature. But this can in no wise be said of the book before us. Although of no great magnitude or weight, and put together to serve an immediate and special purpose—to raise money, as Miss Winifred Stephens tells us, for French sufferers from German barbarity—it is of the very quintessence of literature—literature of the purest, most delicate, and most highly finished type. It is the joint production of some of the most distinguished literary craftsmen on both sides of the Channel—well-known English stylists translating the work of some of the most brilliant writers in the French world of letters—and it is adorned by the brush and pencil of eminent French artists. The work is therefore a timely and significant monument to that generous and lively amity which binds the two nations together in their joint resistance to the power of an evil domination, and we confidently share the hope—nay, we have the firm conviction—that the book will live and be prized as a memorial of an episode in the greatest struggle which has ever been fought for light and liberty against darkness and oppression.

Amidst so much that is excellent it seems invidious to make selections to illustrate the character of this remarkable production. The book opens with an appreciation of France by Mr. Henry James, written with the copiousness and *verve* which characterise all his work. It is followed by a short article by M. J. H. Rosny *aîné*, on British character and policy, translated by Mr. Thomas Hardy, in which, in a few pregnant paragraphs, our national excellences and shortcomings are dealt with in a manner as discriminating and tactful as it is just and true. An essay on the mentality of the Germans, by M. René Boylesve, translated by Dr. W. G. Hartog, is a keen and incisive psychological analysis of the Teutonic mind, written with detachment, and wholly dispassionate—an admirable example of the clear, penetrative insight of French criticism of the highest order. How true it all is Germany will yet come to realise in the awakening which is inevitably in store for her, no matter what the fortune of war may bring. Perhaps the most arresting and striking contribution to the work is the "Debout pour la Dernière Guerre!" by M. Anatole France, done into nervous, palpitating English by Mr. H. G. Wells. How true is all this!

"The prophetic nightmares of our scientific fantastics are being lamentably realised; they come about us monstrously alive, surpassing the horror of Dis, Malebolge, and all that the poet beheld in the Kingdom of Misery. But it is not Martians but German professors who accomplish these things. They have given this war a succession of forms that testify continually to their genius for grotesque evil, first the likeness of the waterspout and typhoon that brought them to the Marne and defeat irreparable, then the sullen warfare of the caverns, then the conflict of metals and chemicals. . . . A philosophical doctor, who sits beside me and reads as I write, interrupts: 'Be certain,' he says, 'that when they abandon that last method they will take to bacteriological war; after the poison gas and the jet of fire they will fight as disease cultures. We shall have to create in every country a Ministry of Anti-Teutonic Serums.' And to this their science has brought them! I recall the *mot* of our good Rabelais: 'Knowledge without conscience is damnation.'"

And how beautiful and how sublime is the invocation with which the whole ends!

"O Britain, Queen of the Seas and lover of justice; Russia, giant of the subtle and tender heart; beautiful Italy, whom my heart adores; Belgium, heroic martyr; proud Serbia; and France, dear Fatherland, and all you nations who still arm to aid us, throttle and end for ever this hydra, and to-morrow you will smile and clasp hands across Europe delivered."

The short essay by M. Remy de Gourmont, translated by Mr. Thomas Hardy, gives a vivid sketch of the condition of that fair land which has been ravaged and defiled by the invader, and in its simple eloquence appeals irresistibly on behalf of those for whom relief is asked. "La Basilique-Fantôme," by Pierre Loti, translated by Sir Sidney Colvin, under the title of "The Ghost of a Cathedral," is a remarkable word-picture of the present state of the cathedral of Rheims, composed with that charm of expression and wealth of imagery which we have learned to associate with the work of its eminent author:—

"Oh, to think of the gross and dastardly and brainless brutality of hurling those canisters of scrap-iron in volleys against the fretwork, delicate as lace, which for centuries had reared itself proudly and confidently in air, and which so many battles, invasions, and whirlwinds had never dared to touch! . . . for all their shameless denials, it was the very heart of ancient France they were bent on here destroying. It was some superstitious idea which drove them to it, not merely their natural instinct as savages; and they worked fiercely at this particular piece of destruction. . . .

"The most irreparable disaster is that of those great stained windows composed by the mysterious artists of the thirteenth century in their devout dreams and meditations, and depicting men and women saints assembled by the hundred with their translucent draperies and luminous aureoles. There, again, the great bundles of German scrap-iron came stupidly volleying and crashing. Masterpieces that no one can reproduce showered down their fragments never to be sorted again, their wonderful golds and reds and blues, of which the secret has been lost, upon the pavement stones. Gone for ever those rainbow transparencies, gone for ever those companies of saints with the charm of their simple attitudes and pale, ecstatic little faces. Those innumerable precious cuttings of painted glass, which in the course of ages had acquired an iridescence like that of opals, lie strewn on the ground, and shattered as they are still gleam there like gems."

Madame Duclaux's "Les Coulisses d'une Grande Bataille," which she translates under the title of "The Background of a Victory," is a charming description, of mingled pathos and humour, of the events of September, as they presented themselves in the fields of the high-lying rolling plains that reach from the Marne to the Seine. She tells of the horror of the women of Melun at the sudden apparition of the Highlanders. "Ce sont maintenant les Allemands," they cried, as the squealing pipers tramped into the old market-square. She has something to say, too, of the imperturbable humour of Tommy and his invincible optimism. "'Are we getting the best of it?' she inquired of one. 'Is there much danger?' 'Well, miss,' said he, 'it's like this: the place is full up with Generals; and I don't know how it is, but I've always noticed where there's so many Generals there's not much danger!'"

She spoke to a douce, demure young Highlander, taking his Sunday afternoon's walk as quietly as if he had been in Glasgow: "How are things going? Do you think the Germans are coming?" "I've been hearing, Matam, that the Chermans will have been hafing a pit of a set-back," said he. And this was how Madame Duclaux first heard of the victory of the Marne.

Space will not permit us to dwell further upon this most interesting and most admirable work. It is in every respect creditable to all engaged in its production, and eminently worthy of the good cause which evoked it, and as such we commend it to all who sympathise with the stricken folk of the invaded Departments. Its price is well within the means of even the poorest of book-lovers, and in purchasing it they will have the satisfaction of knowing that they are not only contributing their mite towards the relief of those who sorely need it, but that they are acquiring possession of what they will come to treasure as a beautiful souvenir of a never-to-be-forgotten time.

T. E. THORPE.

ŒNOTHERA AND MUTATION.

The Mutation Factor in Evolution, with Particular Reference to Oenothera. (Macmillan's Science Monographs.) By Dr. R. R. Gates. Pp. xvi + 353. 10*s*. net. (London: Macmillan and Co., Ltd., 1915.)

SINCE the publication of de Vries's classic work the Œnotheras have attracted more attention than almost any other plant or animal. So extensive a literature has already grown up about them that a critical guide to this great mass of papers would be cordially welcomed by every student of genetics. To some extent Dr. Gates has attempted the task, and if he has not been entirely successful this must be put down more to the immense difficulties of reducing the motley mass of facts to reasonable order, than to any lack of diligence and enthusiasm on the author's part. His book will certainly prove of service to those who wish to obtain some general idea of the problems offered by this famous genus, and have neither the leisure nor the inclination to wade through the thousands of pages, largely in foreign tongues, that have been written upon it.

The principal features of the genetic behaviour of the Œnotheras are brought out, and the author has included a chapter dealing with the cytological side with which he is probably more familiar than anybody else. The book is well produced and amply illustrated, though the nature of the material is against some of the photographs being very illuminating.

In writing this book Dr. Gates evidently had a thesis which he was anxious to prove. He wishes to show that the various forms known as mutants, which are constantly thrown by many varieties of Œnothera, cannot be regarded as the outcome of any process of Mendelian segregation, but that they are due to some other process of germinal rearrangement which is termed mutation. Mendelian segregation, as is well known, is an orderly phenomenon enabling us to predict the gametic output of an individual formed by the fusion of two gametes of different genetic properties. We gather Dr. Gates's contention to be that, because in most cases it has not been found possible to predict the various Œnothera forms arising from a cross, the ordinary rules of segregation do not apply, and that these forms owe their origin to some process not yet understood.

The explanation of this process of mutation is considered by Dr. Gates to reside probably in abnormal divisions of the chromosomes following upon the loss of some hypothetical "condition of balance." He attempts to draw a sharp distinction between this process of mutation and what he terms the Mendelian hypothesis of mutation, by which the new form originates through the loss (or possibly also by the addition) of a definite factor or factors. His point of view is not easy to grasp, and perhaps may be best illustrated by some of his experiments. In a culture of *rubrinervis* some years ago there appeared a new type which he called *rubricalyx*. This form behaves as a simple dominant to *rubrinervis*, and we suppose that Dr. Gates would say that on the Mendelian hypothesis of mutation it arose through the addition of a factor R. When *rubricalyx* was crossed by *grandiflora* (pp. 254–9), a green-budded form, it gave an F_1 generation with red buds, though not so red as in *rubricalyx*. In ten different F_2 families the proportion of reds to greens varied greatly, being in one case as high as 33 : 1, and in another as low as 3 : 1. In a number of F_3 families similar ratios of reds and greens were obtained, while it was shown also that some reds bred true to red, and that green gave nothing but green. Further, there were several cases of an intermediate red breeding here. Dr. Gates argues that the different ratios of reds to greens and the fact of intermediates breeding true negative any Mendelian interpretation. Nevertheless the data as given present so many features in common with cases where a Mendelian interpretation has proved adequate that we feel little doubt that, had the analysis proceeded further, an interpretation in terms of a few factors would have been forthcoming, and we cannot but regret that this promising series of experiments should have been left in so indecisive a state.

Rigorous genetic analysis, working character by character, has yet to be applied to the Œnotheras. That it will prove more complicated than in most plants there is no question. The work already done shows that the Œnotheras, like some other plants, may present differences in the genetic properties of the male and female gametes produced by the same plant. They are also characterised by the high percentage of bad pollen grains, which may mean that some possible combinations are not formed. Indeed Renner has recently shown that in the ovules, too, there may occur an abortion of embryos corresponding to a given class of offspring (*cf.* Gates, p. 248). Differences in viability, as Dr. Gates points out (p. 89) may also characterise different forms. With all these possible sources of complication to be taken into account it is not surprising that the genetic behaviour of the Œnotheras is still in a state of chaos, and until proper methods of analysis have been applied and proved definitely to fail, it is surely premature to state that the ordinary rule of segregation does not occur in this genus.

In conclusion there are a few small alterations which we should like to find in another edition. "20" on line 3 of p. 23 should surely be "20 per cent.," and to call Drosophila a "pumice-fly" (p. 303) might lead to misapprehension as to the manner of its subsistence. We think also that in an English book the form Venice is to be preferred to Venedig (p. 248). A common error is perpetuated in the sentence on p. 320—"The new character is, at least in some cases, a dominant in crosses, which accounts for its spreading." The dominant, *qua* dominance, has, of course, no advantage over the recessive in a mixed population.

EVOLUTION THE OTHER WAY ABOUT.

Histoire de l'Involution Naturelle. By E. Marconi. Translated from the Italian by M. I. Mori-Dupont. Pp. xii + 505. (Paris: A. Maloine, 1915.) Price 15 francs.

THE evolution-theory aims at formulating the way in which the present-day state of things has come about. It is not demonstrable like the law of the conservation of energy; it is a way of looking at things—an interpretation. It reads the present as the natural outcome of the past. In this broad sense Dr. Enrico Marconi might be called an evolutionist, but he refuses the label, having a special theory of his own. According to the generally accepted interpretation the great movement of the ages has been in the direction of increasing complexity and control (differentiation and integration), always allowing for some simplification in the case of parasites and other degenerates. But according to Dr. Marconi's interpretation the historic movement has been in the opposite direction. Mammals did not evolve from a Reptilian stock, but Reptiles from Mammals. Amphibians did not spring from a Piscine stock, but Fishes from Amphibians. The mistake that evolutionists have made in contemplating the stream of life is not a little one; they have actually mistaken the direction of the current! The author asks us to replace the evolution-idea by the involution-idea.

This arch-heresy has been suggested before, but it has never had, so far as we know, such an elaborate and beautifully printed presentation. The author is obviously sincere and in earnest, but he has not learned the humility of refraining from discussing questions, such as cell-division, which he has utterly failed to understand. What are we to say of this ingenuous and occasionally ingenious heretic?

There was a time long ago when our earth was too hot to offer hospitality to any living creatures of the sort we know about, and it is useless to speak of others. Therefore, so far as the earth is concerned, "matter" antedated "life." But it is open to anyone to defend the metaphysical thesis that in the world as a whole "life" is antecedent to "matter." We would not quarrel with Dr. Marconi over a luxury of this sort. But when we remember the fact that according to the rock record there were invertebrates before there were any vertebrates, and fishes before there were any amphibians, and reptiles before there were birds and mammals, and so on, we require arguments more cogent than Dr. Marconi's to persuade us to become "involutionists." And as to the development of the individual, while we agree with the author that the recapitulation doctrine requires careful handling, we do not think that the life-history of a frog, for instance, offers any suggestion whatsoever of the reptilian origin of amphibians.

We shall not discuss Dr. Marconi's detailed arguments that cyclostomes sprang from gnathostomes, and ascidians from amphioxus, and echinoderms from enteropneusts, and the branchial arch system of a dogfish from the thoracic skeleton of a mammal, for in truth what he says lacks zoological competence. It would have been profitable if Dr. Marconi had followed Dr. Dohrn and Sir Ray Lankester and restricted himself to illustrating the occasional occurrence of degenerative or involutionary changes in the history of animal life, but the author will have no half-measures. From an originally perfect manifestation of life man has fallen; and the ape and the tiger, the mole and the bat are his descendants!

When we read the words "involution naturelle" on the title-page we hoped that some light would be cast on Prof. Bateson's recent hard saying: "We may as well see whether we are limited to the old view that evolutionary progress is from the simple to the complex, and whether after all it is conceivable that the process was the other way about." But while Dr. Marconi is convinced that it has been the other way about, he starts from a super-man, and we do not suppose that this expresses Prof. Bateson's conception of primordial life. In one of Dostoievsky's novels it is quaintly remarked of one of the characters that he was the only man in the company who could move about on his head. We think that the author of this extraordinary, topsy-turvy interpretation of the world must be similarly unique.

ELECTRICITY FOR THE FARM.

Electricity for the Farm. By F. I. Anderson. Pp. xxiii+265. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 5*s.* 6*d.* net.

THIS book is addressed particularly to American farmers who may not know how easy it is to make use of a stream of water in producing electric power and transmitting it for lighting and heating and mechanical purposes on a farm. It shows that the initial cost is usually small, that measurement of power is simple, that although the farmer must buy apparatus he can do this without employing an expert, and that he need have no difficulty in putting it up and getting it to work in such a way that it will give no trouble afterwards.

The author knows his farmer well, and his explanations are obviously such as will be understood. How to compute the power required for so many lamps in rooms and out-houses; for so many heaters of various kinds; for so many motors doing small or large domestic or farm work. How to measure the amount of water flowing in a stream, and knowing the fall to calculate the power of the stream. The farmer or his son, who will probably become an enthusiast, is supposed to have much common sense and a knowledge of simple arithmetic; he will certainly in time get a good working knowledge of electrical engineering. The author makes remarks which may cause a physicist to smile; for example, "a falling body hits the ground with precisely the same force as is required to lift it to the height from which it falls." He evidently means that the work done in lifting the body is equal to the energy which it will expend in falling. His instructions as to the measurement of water by weirs are too inaccurate to please a water engineer, but they are really accurate enough for the farmer's purpose. His descriptions of turbines are too complex for the farmer and they do not show great knowledge of the subject, but the farmer does not need to understand them. The author is excellent in describing how to make a dam. His description of the dynamo is quite good and easy to follow, and it will certainly interest the farmer in electricity and cause the farmer's son to study the subject more fully, not merely through books, but through simple experiments. On practical matters—types of lamps, sizes of wire, wire joints, Ohm's law, wiring the house and premises, etc.—the author gives good simple instructions. The last quarter of the book is less important; it is intended for farmers who have no water power. It describes gas-engine plant and accumulators.

The American farmers have a respect for natural science and they are glad to cultivate new ideas. We think that the publication of this book will induce such men and their families to begin a fascinating study at small cost, with results in comfort and a widening of the mental horizon which ought to fill the town dweller with envy.

PRINCIPLES OF STOCK-BREEDING.

Breeding of Farm Animals. By Prof. M. W. Harper. Pp. xvii + 335. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd., 1914.) Price 1.50 dollars.

FEW callings have been more prolific in theories than stock-breeding. Many have been erroneous, while others which have borne a strong semblance of soundness have been inapplicable. Most of them have come from stock-breeders themselves; but others, which, as a rule, have received more attention, have come from outside observers. The great stock-breeders, more especially the great improvers, have given little heed to any other theory than that which has been tersely expressed in the words "put the best to the best," but others have been influenced by other theories, although their success in the production of good stock has usually been parallel with the strength of their adherence to the main theory whether that adherence was conscious or unconscious. After the introduction of printed herd and stud books, and therefore of "pure" breeding, the "pedigree" theory was generally taken to be a means of breeding good stock as well as "pure" stock, and only the very greatest stock-breeders stood fast by the "best to best" theory.

Like many a stock-breeder, Prof. Harper has lost sight of the main theory, and has allowed others to intervene. With him the Darwinian theory has effect as follows: "While the influence of climate and locality is great, and the factors at work are exceedingly complex, yet from a practical point of view we may consider the food supply and more favourable conditions generally, such as sufficient shelter, proper care, including training and developing, as the more important causes of variation." A paragraph is headed "Mendelism a Cause of Variation." And, after three chapters on Improvement due, 1, to "selection based on records of performance," 2, to "selection the result of prepotency," and, 3, to "accumulative development," it is stated "that the degree of development depends on the environment, including training, management, and the like." Apparently the weight of Bateson's "Materials for the Study of Variation," and Mendel's work has not yet been felt. It is no argument for the Darwinian view to say that "The thoroughbred horse has increased its speed by but eight per cent. in one half a century of racing. During this same period the standard-bred, *a comparatively new breed*, has reduced its trotting record by 27 per cent." The words in italics indicate some part of the argument to the contrary.

Parts of the work of Galton and Pearson are cited, but with no indication how the formulæ of these investigators, even if sound, are to be made use of by stock-breeders; and the idea that "the new individual inherits all the characters of the race to which it belongs," which is cited frequently and appears to be regarded as fundamental, is of very doubtful accuracy when applied to domestic animals. In the chapter headed "Mendel's Law of Heredity," the statements are made that "Mendel made a series of studies . . . from which he drew some general conclusions, now known as Mendel's law of heredity," and "Mendel's Law . . . depends on three factors—unit characters, dominance, and segregation." Apparently Prof. Harper has become acquainted with Mendel's Law from later writers rather than from Mendel himself.

In his volume, however, a source of information of very great importance is indicated. In the United States, careful records have been kept of the performances of the Holstein-Friesian breed of cattle, and these show that, as they had none, or one, or two parents in what is called the advanced registry, certain sires and dams had different chances of begetting progeny capable of entering the same registry. Surely if these records were closely examined and the failures counted as well as the successes, a more satisfactory theory might be promulgated as to the inheritance of milk and butter yield. The records of trotting horses have also been kept, and the belief is strong that some are the parents of performers while others are the grandparents only: the intervening generation being merely breeders of performers. Surely, again, the failures might be counted and some useful explanation of this phenomenon discovered.

James Wilson.

OUR BOOKSHELF.

The Material Culture and Social Institutions of the Simpler Peoples: An Essay in Correlation. By L. T. Hobhouse, G. C. Wheeler, and M. Ginsberg. Pp. 299. (London: Chapman and Hall, Ltd., 1915.) Price 2*s.* 6*d.* net.

It is difficult, and may be dangerous, to apply statistical methods to the sociology of uncivilised peoples. There are only a few monographs written on scientific lines; the greater part of the evidence consists in the incomplete and often prejudiced accounts of travellers. Results, therefore, over a wide field, must necessarily be rough, and, to attain even these, a very skilled judgment is required. But, for all that, even rough results of very careful work are valuable.

The authors of this study in correlation wisely choose material culture as the general characteristic of civilisation. By reference to this test, they have established "an advance in organised government accompanying economic development." Similarly, with the social order generally. The chapters dealing with these results are quite masterly, and the authors have the good habit of stating fully their difficulties, and the pros and cons, in the doubtful cases. In various ways it is shown that a purely pastoral society tends to become a "blind alley" of progress. Interesting results follow the discussion of marriage and the family, especially in the cases of polygamy and the "consideration" to the kin.

Full tables of all the data used are given, and there is a complete bibliography. The book is absolutely essential to the student of social evolution. It breaks fresh ground and consolidates new positions.

Agricultural Laboratory Manual: Soils. By Prof. E. S. Sell. Pp. iv + 40. (Boston and London: Ginn and Co., 1915.) Price 1*s.* 6*d.*

This is a collection of forty exercises on soils. The book consists of forty sheets of scribbling paper held together by paper-fasteners inside a brown paper cover, so that each sheet may be used separately by the scholars and then bound up again with the rest. Each page has a few lines of printed directions at the top, followed in many cases by a ruled form in which the student is intended to enter his results.

The exercises are intended "for high schools, agricultural high schools, and normal schools." There is a list of apparatus required for the exercises, which includes such diverse articles as pie-tins, tomato-cans, compound microscopes, mill for pulverising soil (why not pestle and mortar?), and a compacting machine for soils, whatever that may be. The exercises themselves include the formation of soils as seen in a road or railway cutting; experiments on the separation of soil particles, their appearance and properties; the properties of sand, clay, and humus; the behaviour of water and air in the soil; cultivation, implements, fertilisers, and gardening. A teacher who lacked the knowledge or experience requisite for designing exercises himself might find some of the suggested exercises useful, but such a teacher would find himself in trouble with more than one of the exercises. No. 19, for instance, where the scholar is directed to find the percentage of air in the soil by putting a measured volume of soil in a beaker and pouring water on to it until the soil is just covered, would be likely to give very curious results. Again in exercise No. 27, a scholar who was accustomed to working with pie-dishes and tomato-tins would see all sorts of things except bacteria when "examining with a compound microscope a small sample of fertile soil placed on a slide in a few drops of water."

T. B. W.

The Evolution of the Potter's Art. By T. Sheppard. Pp. xx. (London: Brown and Sons, Ltd., n.d.)

The pretentious title of this publication will disappoint the student in search of an adequate treatment of a difficult problem. Such a work would not be an easy task for even the most learned ethnographer, because it involves a knowledge of prehistoric and savage culture, acquaintance with the technique of work in clay, and a special familiarity with burial customs. It would be unfair to expect these qualifications in the hard-worked curator of a provincial museum. But it is sufficient to quote his comment on the discovery in pots from the so-called Danes' Graves near Driffield of the humeri of pigs: "so that we may assume that a shoulder of pork was food for the gods in the Early Iron Age." He must be aware that the joint was intended as food for the dead man's spirit. The book is really only an *edition de luxe* of one of the useful penny pamphlets which Mr. Sheppard has issued from time to time for the instruction of unlearned visitors to the museum at Hull. It is fortunate in possessing a good collection of early Staffordshire ware, with examples of the Worcester, Derby, Chelsea, Dresden, and other famous schools. From these materials the "Evolution of the Potter's Art" is worked out in six pages. The best point about the work is the series of sixty-two photographs of the more interesting specimens in the collection.

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.*]

Colour Sensation.

IN NATURE of July 15 there is given an abstract of a paper by Dr. F. W. Edridge-Green in which he gives reasons for supposing that the sensation produced by spectral yellow is a simple sensation, and not a compound of red and green, as supposed by the Young-Helmholtz theory. In 1872 I read a paper on colour sensation before the Royal Scottish Society of Arts, in which practically all the experiments described by Dr. Edridge-Green are given, but the conclusion come to was that spectral yellow gave a compound sensation, because it could be altered by fatiguing the eye with either red or green. I have lately repeated these tests, and find my eyes still give the same reactions. To my eyes, the best yellow is just on the green side of the D lines in the spectrum, but if the eye is fatigued with red light the yellow is changed to greenish-yellow, and if fatigued with green it is changed to orange, that is, the yellow changes in colour towards the unfatigued sensation. Testing by means of a sodium flame gives the same result. In making this test, the flame should not be used immediately after lighting it, as it then contains, in addition to the bright yellow lines, a continuous spectrum. The test should be made when the flame is nearly burnt out and the salt crackling. In that condition only the yellow lines are visible, and it shows the change better than in its first condition. To the eye fatigued with red it has a distinct greenish hue, while to the other eye fatigued with green it is reddish. The change is quite marked, and there is no hesitation as to the conclusion.

With regard to the results given in the abstract of Dr. Edridge-Green's paper: (1) Fatiguing the eyes with pure yellow spectral light could hardly be expected to affect the hue of the red, and could only slightly diminish its brightness, which will be difficult to detect. (2) It is difficult or impossible to compare results when the eye in one case is flooded all over with a bright light, and the other in which it is fatigued with a narrow strip of weaker light which cannot be kept on the same part of the retina for any length of time. Results (3) and (4): Dr. Edridge-Green's eyes and mine do not give the same results as stated at the beginning of this letter.

It may be stated that the after-image seen on a white surface after looking at spectral yellow, and by the sodium flame, is the same as that given by a yellow compounded of red and green. Now if spectral yellow gave a simple sensation we would hardly expect this, as the after-image is a compound of all the unfatigued sensations, and we would expect spectral yellow if simple ought to give a nearly white after-image, and not a violet one.

There is an old saying that "Seeing's believing." In ordinary matters this may be so, but the belief is not necessarily true, and in questions of colour full of pitfalls. No two pairs of eyes see colours alike. This does not refer to colour-seeing and colour-blind eyes only, but there is reason to believe that all eyes differ more or less in their perception of colour, and questions of this kind can only be settled by the decision of many eyes, and their decision only applies to themselves. JOHN AITKEN.

Ardenlea, Falkirk, August 10.

"The History of Upper Assam, Upper Burmah, and North-Eastern Frontier."

I HAVE had the opportunity of looking through this recent publication, which was reviewed in NATURE, vol. cxiv., p. 481, December 31, 1914. It is most interesting reading to anyone, but particularly to those like myself who spent many years on the Eastern Frontier among the tribes mentioned. This book covers so large an area, goes back so far into the past history of Assam since the East India Company were brought into relation with that country, and further back into a lost history of its ancient greatness, that 256 pages cannot do the subject justice. Very much which has been written of Assam, particularly in the Journal of the Asiatic Society of Bengal and other publications, is not referred to at all, while certain parts are very sketchy, even inaccurate. At the same time, very much that Colonel Shakespear has written is extremely interesting, and his knowledge and experience are very considerable, from having served so long in the country, and his conclusions sound. On p. 108, treating of events in the Dafla country in 1874, when Colonel Stafford commanded a force which entered the country, we find :—

"The Daflas made no resistance, but paid up fines and returned the captives. *Little or nothing was done by this large force in exploration or survey*, and it returned to Assam amidst a clamour from Government over wasted money" (the words in italics are mine. I would answer this statement by the following extracts from Reports, etc.).

I. The Indian Museum, 1814–1914. Calcutta, 1914. "Bhutan is still an unknown country to naturalists, and its territory represents the most important gap in our geographical knowledge of the Himalayan fauna. East of Bhutan two expeditions of very different date are of zoological importance, namely, the Dafla expedition of 1874–75 and the Abor expedition of 1911–12. On the first of these, Godwin-Austen, then a Major in the Bengal Staff Corps attached to the Survey of India, himself made collections of great value, and also encouraged his subordinate officers to do the like."

II. As to the survey work. In a Memoir on the Indian Surveys, by Clements R. Markham, C.B., F.R.S. India Office Publication. 1878, p. 173.

"In 1875 Major Godwin-Austen accompanied the Duffla military expedition against the tribes on the northern frontier of Assam. Narainpur, on the Dikrung Nullah, was reached on December 2, 1874, and from a base on the banks of the Bramaputra a short series of triangles was extended northward into the Duffla hills. Owing to the brief period during which the military were in the country, the survey party were unable to remain beyond two and a half months. The out-turn of work amounted to 1705 square miles of entirely new topography, on the scales of two and four of the season's work in the Duffla hills, has been compiled by Major Godwin-Austen, and is a valuable addition to our geographical knowledge of the region beyond the northern frontier of Assam. Lieut. Harman, R.E., rendered assistance by surveying the course of the Ranga river; and Mr. Lister, of the Royal Botanical Gardens, Calcutta, was assiduous in making a collection of plants, seeds, and dried botanical specimens. The Surveyor-General expresses a hope that these explorations on the Northern Assam frontier will be continued, and is of opinion that with tact and precaution all difficulties in the way of visiting and exploring the narrow strip of hills between the Assam valley and Tibet may be overcome."

As to the natural history work, there was published:—

III. Journal Asiatic Society of Bengal, vol. xliv., part ii., 1875: Notes on the Geology of part of the Dafla Hills, Assam; lately visited by the Force under Brigadier-General Stafford, C.B., by Major H. H. Godwin-Austen, F.R.G.S., F.Z.S., etc., Deputy Superintendent Topographical Survey of India, with map. Plate ix.

IV. Journal Asiatic Society of Bengal, vol. xlv., part ii., 1876: On the Helicidæ collected during the Expedition into the Dafla Hills, Assam, with plate viii., p. 311.

V. On the Cyclostomacea of the Dafla Hills, Assam, p. 171, with plates vii. and viii. *a*.

VI. List of the Birds collected on the Expedition into the Dafla Hills, Assam, together with those obtained in the adjacent Darrang Terai, with plates iii. and iv., p. 64, by same author.

H. H. Godwin-Austen.

Moustier Implements and Human Bones in Suffolk.

Owing to the liberality of the trustees of the Percy Sladen Memorial Fund, I have been enabled during the past eighteen months to conduct a continuous series of excavations in the south-west corner of Messrs. Bolton and Laughlin's brickfield, Ipswich, where a well-marked "occupation-level" occurs resting upon a weathered surface of chalky boulder clay, and covered by a very hard and compact sandy loam of a greyish colour. It appears that since the people lived who occupied this "floor" the valley, which is now dry, has been deepened considerably, and as the "floor" passes into a small escarpment to the south at a depth of about 10 to 12 ft. from the surface of the ground, it seems that a considerable antiquity must be assigned to the human relics associated with it. The occupation-level under investigation is very rich in flint implements, which, in my opinion, must be assigned to the Moustier epoch. (Traces of another occupation-level occur above the Moustier deposit, containing implements of a totally different type which approximate to the earlier Aurignac examples.) With the flints have been found several hundreds of animal bones, representing chiefly the remains of the horse, and one specimen referable to the mammoth. Numerous fragments of very rough and primitive pottery occur in the floor, and tend to support Dr. Rutot's claim that about five hundred fragments of pottery were found at Caillou-qui-Bique, associated with an upper Le Moustier industry. Three portions of the human skeleton have been found scattered upon the "floor" with the flints and mammalian bones. These comprise a small portion of the upper margin of the occipital bone of a skull 10 mm. in thickness, the shaft of the left humerus of a woman, and the shaft of the right femur of a man. There seems little doubt that any of the bones found belonged to individuals of the Neanderthal race. All the human and animal bones are well preserved and in a condition of fossilisation. The excavations are still in progress, and it is hoped that further discoveries will be made. J. Reid Moir.

12 St. Edmund's Road, Ipswich, August 13.

THE GAS INDUSTRY AND EXPLOSIVES.

The need that has arisen for certain coal-tar products for the manufacture by nitration of the high explosives essential in the present war, has riveted attention on the best methods for obtaining these, and of keeping up the supply to the highest possible amount during the period of hostilities.

The substances most needed are the aromatic hydrocarbons, of which benzene forms the base from which the newest and most powerful of these explosives, tetranitroaniline, is prepared, and also the tetranitromethylaniline, which under the name of "tetryl" is playing an important part in detonators and primers. Toluene, the next member of the aromatic group, is needed in enormous quantities to nitrate to trinitrotoluene, or T.N.T., whilst carbolic acid is the base from which picric acid is formed, this body under slightly varying conditions being the English explosive lyddite, the French melinite, and the Japanese shimose powder.

The aromatic hydrocarbons found in the coal-tar are only a small proportion of those existing in the gas, as the volatility of the so-called benzols—benzene, toluene, and xylene—causes the largest proportion of them to be carried forward as vapour in the coal gas, and on cooling this gas and scrubbing it with creosote oil a much larger yield is obtained from the gas than from the tar.

The formation of these bodies is due to the action of heat on the primary constituents of the decomposition of the coal, and when coal is distilled at very low temperatures the primary products of the decomposition, which largely partake of the character of paraffins, *i.e.*, saturated hydrocarbons, are found, whilst the aromatic hydrocarbons are to all intents and purposes absent. As the temperature of carbonisation is raised, the paraffin hydrocarbons become less in quantity, and naphthenes make their appearance in the tar. At still higher temperatures, these naphthenes split off hydrogen and become converted into aromatic hydrocarbons, such naphthenes as hexahydrobenzene being converted into benzene with evolution of hydrogen. As the temperature of carbonisation is still further increased, the tendency is for these bodies to become converted into naphthalene, whilst the employment of very high temperatures with light charges gives rise to a tar which contains only very small traces of aromatic hydrocarbons, large quantities of naphthalene, and a very large proportion of free carbon, produced by the degradation by heat of the other hydrocarbons present.

When, however, vertical retorts and heavy charges with horizontal retorts were introduced, a marked improvement in the quality of the tar took place: the heat from the walls of the retort passing slowly into the mass of coal distilled off the tar vapours at the lowest possible temperature, and these, finding an exit through the comparatively cool core of the coal to the mouthpiece, a large proportion of the lowest temperature tar was produced. As the charge became more and more thoroughly carbonised, the central core became blocked with pitch and tar distilled forward into the coal mass, and the gas and tar vapour being in this latter stage forced to find their way through the outer shell of red-hot coke, became degraded to the utmost limit, and gave very large volumes of such permanent gases as hydrogen mingled with methane, the least easily broken up of the hydrocarbons, the result being that the modern tar is in reality a mixture of low temperature and very high temperature tar. Such a tar, obtained from a good gas coal, will contain approximately :—

Benzol	0·60 per cent.
Toluene	0·15 ,,
Solvent naphtha	1·00 ,,
Heavy naphtha	1·65 ,,
Carbolic acid	0·6 ,,
Cresylic acid	0·9 ,,
Creosote oil	30·6 ,,

The remainder is naphthalene, anthracene, and pitch.

If the gas from the carbonisation be scrubbed, and the absorbed hydrocarbons be distilled out from the creosote oil and added to the light hydrocarbons obtained from the tar, the total yield is :—

Benzol	2·1 per cent.
Toluene	2·1 ,,
Solvent naphtha	2·6 ,,
Heavy naphtha	2·6 ,,

It is found in practice that the carbonisation under the ordinary gasworks conditions of a ton of good bituminous coal yields about one-third of a gallon of toluene from tar and gas.

In practice, the withdrawal from the gas of all the hydrocarbons that can be scrubbed out by creosote oil would reduce the heating value of the gas to a considerable extent, and various methods of getting over this trouble have been proposed, such as enriching the scrubbed gas by the benzene and xylene from the crude benzol after separation of the toluene by fractional distillation, or by so scrubbing the original gas that only about one-third of the crude benzol is withdrawn, as by such means the calorific value of the gas can be maintained at or above the statutory minimum of 500 British thermal units.

The tar and gas made in small country works as a rule contain more aromatic hydrocarbons than the products from large works, as the temperatures used in carbonisation are not so high; and should the Government need still larger quantities of toluene and carbolic acid for nitration, the gasworks of the Empire could treble the output by reverting to the temperature and methods employed before the introduction of regeneration in the furnaces. This, however, would reduce the gas yield from the 13,000 cubic feet per ton now aimed at by the gas manager to 10,000 cubic feet, but the higher calorific value of the gas would allow of the volume being made up by the addition of blue water gas.

THE ELECTRONIC THEORIES OF THE PROPERTIES OF METALS.

In a course of lectures delivered at the Cavendish Laboratory during the Michaelmas term of 1886, Sir J. J. Thomson examined the dynamical result of assuming the passage of electricity through a metal to be of the same nature as through an electrolyte. The subject was dealt with more completely in "Applications of Dynamics to Physics and Chemistry" in 1888. The later discovery of the electron which might act as a carrier of electricity from molecule to molecule placed the idea on a much firmer footing, and in 1898 Riecke developed theories of the electrical and thermal conduction and thermo-electrical properties of metals, based on the existence between the molecules of carriers of positive and negative electricity. Two years later Drude worked out more systematically theories founded on the same basis, and it is his work which is usually quoted in accounts of electronic theories, generally with the simplification that only one type of carrier—the negative electron—is taken as moving freely between the molecules. These electrons are supposed to be produced by the dissociation of the electrically neutral metal atoms, what remains of the atom being left positively charged.

The moving electrons are assumed to have the same average kinetic energy as a molecule of a gas enclosed in a cavity in the metal would have. The nature of the impact of electron on metal atoms is not discussed, but as the motion of each metal atom is likely to be comparatively small, the gas laws which hold for the motions of the molecules of a light gas amongst those of a much heavier are applied and the electrons are said to have a mean free path of length λ. The motions are distributed in all directions equally, and the electrons cannot escape through the surface of the metal unless their speed perpendicular to the surface exceeds a certain limit. The action of ultra-violet light on the surface facilitates the emission.

When an electromotive force is applied to the metal there is superposed on this to and fro motion of the electrons a drift up the electric field, the relation of which to the field is such that the specific conductivity of the metal is proportional to $n\lambda/\sqrt{T}$ where n is the number of free electrons per cubic centimetre and T is the absolute temperature of the metal. Since the electrical conductivity of a pure metal is known to vary approximately inversely as the absolute temperature, this implies that $n\lambda$ must vary inversely as $\sqrt{T}$. As there is nothing on the one hand to suggest so considerable a change of the free space between the metal atoms with temperature, while on the other the facts of thermoelectricity are against any considerable decrease in the number of electrons per c.c. as the temperature rises, it sems difficult to reconcile the law of variation of $n\lambda$ with experimental facts.

If a slope of temperature exists in a metal, the electrons coming from the hotter side of a cavity between two metal atoms will move more rapidly than when coming from the colder. There will therefore be a drift of energy towards the colder metal which bears to the slope of temperature such a relation that the heat conductivity of the metal is proportional to $n\lambda\sqrt{T}$. As the heat conductivity of a pure metal changes very little with change of temperature, this equation again implies that $n\lambda$ varies inversely as $\sqrt{T}$, and we have the same difficulty in understanding how this is brought about. On dividing the heat conductivity by T times the electrical conductivity the product $n\lambda$ disappears from the result, and we obtain a constant the value of which should be approximately $2 \cdot 3 \times 10^8$ for all metals at all temperatures. At air temperatures the values found experimentally vary between 2 and 3×10^8, and at very low temperatures between $1 \cdot 5$ and 3×10^8. The agreement between the two results is undoubtedly good, but when the calculations are improved in accuracy by taking into account the variation of the speeds of the electrons about the mean value used by Drude, Lorentz finds the constant $1 \cdot 5 \times 10^8$, which is not in such close agreement with experiment. For alloys and conducting salts the experimental values are considerably higher than for pure metals, and Koenigsberger and others have put this down to the part played by the atoms themselves in the conduction of heat. For quartz and other electrical insulators which are good conductors of heat there can be no question of the insignificance of the *rôle* of the free electrons.

Owing to the different values of the concentration n of electrons in different metals, there will be a flow of electrons through the surface of contact of two metals till the potential difference produced stops the flow. In an unequally heated metal the same process of compensation will occur. In the former case we get the Peltier and in the latter the Kelvin effect. The former agrees in order of magnitude with the values found by experiment, but as Sir J. J. Thomson has pointed out, it is difficult to reconcile the great decrease of electrical conductivity of a metal on melting with the small Peltier effect between solid and molten metal. The calculated Kelvin effect shows that the concentration n of the electrons must in all metals be nearly proportional to $\sqrt{T}$, a result which is not easily reconciled with that for $n\lambda$ deduced from the electrical or thermal conductivity.

Since a negative electron in motion in a magnetic field is acted on by a force transverse to its path, the theory affords a simple explanation of the Hall effect, and gives the right sign and order of magnitude for the effect in bismuth at ordinary temperatures, but the wrong sign for the effect at low temperatures, and for the effects at ordinary temperatures in iron and antimony.

In no field can the simple electron theory be said to have given a satisfactory quantitative account of the facts, and its elaboration in one region has in general led to greater difficulties in others. The kinetic energy of the electrons it postulates is so great that an increase of 1° C. in their mean temperature involves a supply of heat ten times the specific heat of the metal. After pointing this out Sir J. J. Thomson, in 1907, in his "Corpuscular Theory of Matter," developed a new theory which may be called the doublet theory. According to this theory the atoms of a metal are grouped together in pairs, one of each pair positively, the other negatively charged. In ordinary circumstances the axes of these doublets point in all directions on the average equally. Under the action of an electric field the doublets tend to arrange themselves in lines, with the positive end of one near the negative of the next, and electrons may pass from the negative end of one doublet to the positive of the next, and so along the line of doublets.

On the assumption that the axis of the doublets distribute themselves according to the gas law, that their centres are spaced on the average b apart while the charges of the same doublet are d apart, and p electrons are discharged from a doublet per second, the electrical conductivity of the medium works out proportional to $nbdp/T$ where n is the number of doublets per c.c. and T the absolute temperature. The experimental facts show that $nbdp$ is independent of temperature. In the same way the transport of kinetic energy by an electron leaving a doublet at a higher, and joining one at a lower temperature, leads to a heat conductivity proportional to nb^2p, which the experimental facts show is independent of temperature. The quotient of the heat conductivity by T times the electrical conductivity on this theory comes $2 \cdot 6b/d \times 10^8$, and as b/d must be greater than unity the agreement with the experimental value 2 to 3×10^8, is about as good as in the case of the simple theory. The presence of the b/d makes it possible to include in the theory those substances for which the quotient is high.

At the junction of two metals the excess flow from one metal will cause a difference of potential and an electric field which will change the orientation of the doublets until the flows are equalised. In an unequally heated metal the same method of compensation will come into play, and we have the Peltier and Kelvin effects.

If the rotation of a doublet in an electric field does not take place about the middle point, the two charges of the doublet move with different speeds. If they are in a magnetic field its action on them will tend to incline the axis of the doublet to the plane containing the two fields, and there will be a flow of electrons at right angles to both fields. The direction of the flow will be determined by that of the end of the doublet which moves most quickly. We thus have an explanation of the Hall effect, whether it be positive or negative.

No numerical comparisons of theory with experiment appear to have been made in the case of these thermo-electric and thermo-magnetic effects.

In his addresses to the Institute of Metals on May 5, and to the Physical Society on June 25, Sir J. J. Thomson dealt with the modification of his theory necessary to bring it into line with the discovery by Prof. Kamerlingh Onnes that at very low temperatures—4° or 5° absolute—the electrical conductivities of metals become infinite. The external electric field applied to the metal is assisted in bringing the axes of the doublets into line by the field produced by those doublets already in line. The kinetic energy of thermal motion of the doublets tends to destroy the alignment. At ordinary temperatures it is sufficient to destroy the alignment so soon as the external field is withdrawn, and the flow of electrons from doublet to doublet is stopped. But at very low temperatures the energy is not sufficient to modify an alignment once produced, and the flow of electrons continues when the external field is withdrawn. The conductivity in these circumstances will be very high.

From this short account of the present position of the two theories it will be seen that the doublet theory of Sir J. J. Thomson has shown a greater power than the electron theory of co-ordinating the facts of experiment. It has difficulties of its own, both in the nature of its fundamental assumptions and in its power of reproducing the facts quantitatively. It does not appear to provide electrons for emission by incandescent bodies, and in its latest development it involves serious changes not previously suspected in the thermal, thermomagnetic, and thermogalvanic properties of metals at the very low temperatures attained by Prof. Kamerlingh Onnes. But the great flexibility it has shown justifies a more generous treatment of it by those authors and lecturers who have been content to limit their exposition of these questions to the older electron theory.

C. H. LEES.

THE STERILISATION OF WATER.

THE safeguarding of our water supplies is of particular importance at the present time, for there may be considerable risk of pollution if typhoid and cholera cases or "carriers" arrive in any number from the seats of war, as may well be the case. The research work carried out by Dr. Houston is therefore of much value and is summarised in a Report just issued.[1]

Dr. Houston first deals with his "excess lime" method of purification. The hardness of water is chiefly due to bicarbonate of lime (temporary) and sulphate of lime (permanent), the former being kept in solution by the carbonic acid present. In the softening of water lime is added and combines with the free and semi-combined carbonic acid, causing a precipitation of the lime added and of the bicarbonate of lime in the water in the form of the relatively insoluble carbonate of lime. A water treated with the right amount of lime has no caustic alkalinity and has practically no action on the bacteria present. When more than enough lime is added the water is rendered caustically alkaline and becomes actively bactericidal. Such a water would, however, be unfit for domestic and trade use, but if the excess of lime present be removed by the addition of a sufficiency of water from which the bacteria have been removed, the whole of the mixed water will be softened and purified, and will be satisfactory for all purposes. Dr. Houston has previously shown that if raw river water be stored for from four to five weeks the great majority of the bacteria are removed, and the water is rendered safe for drinking purposes.

The excess lime method of purification consists, then, in the addition of an excess of lime, storage of the alkaline water for a day or thereabouts, so that the bactericidal action may be exerted, addition of a sufficiency of water, purified by storage, to neutralise the excessive alkalinity, and filtration to remove the precipitated carbonate of lime.

Dr. Houston has tested the method on a large scale at Sunbury and at Aberdeen. At Aberdeen *Bacillus coli* (which may be taken as an index of pollution) was present in the untreated water in from 1 c.c. to 100 c.c.; after treatment it was not found in 100 c.c.; the process is therefore efficient and it is comparatively inexpensive.

Another research which has been carried out by Dr. Houston is an investigation of "water microbes" giving the cholera-red reaction after incubation of cultures for twenty-four hours. The cholera-red reaction (obtained by adding acid to a culture) is a very constant and characteristic reaction of the cholera microbe, and as this organism is frequently conveyed by water, it is important to know whether water organisms other than cholera yield the reaction. It is satisfactory to find that, although eighty microbes out of approximately 1885 sub-cultures gave the cholera-red reaction on first being tested, they were easily distinguished from cholera by the application of two or three further simple tests.

Dr. Houston is to be congratulated on the valuable research work he has been able to carry out in the midst of a vast amount of routine work.

R. T. HEWLETT.

[1] Metropolitan Water Board. Eleventh Report on Research Work, together with Index to Research Reports, Nos. i–x inclusive. By Dr. A. C. Houston. Pp. vii+52. (London: Metropolitan Water Board, n.d.) Price 2s. 6d.

THE LATE PROF. J. COOK WILSON.

DEATH has of late been busy among Oxford residents. The demise of John Cook Wilson, Wykeham Professor of Logic, was not unexpected, for he had been in bad health for more than a year, and indeed had never recovered completely from the shock of his wife's death in January, 1914. Cook Wilson was a man of quite exceptional attainments. Born at Nottingham and educated at Derby School, he matriculated at Oxford in 1868. As scholar of Balliol he took no fewer than four first classes, two being for mathematics and two for classics. These were followed by the Latin Essay, the Conington Prize, and a fellowship at Oriel. After his election as Wykeham Professor he became a fellow of New College, but his affection for Oriel never waned, and his connection with his old college was of late years renewed by an honorary fellowship. His lectures and less formal courses of instruction were keenly appreciated, and his influence on the philosophical and logical studies of Oxford was very great. His published works, though giving evidence of much learning and critical acumen, were not copious in relation to the width and depth of his erudition. Cook Wilson was a man of strong views. These he was always ready to maintain with an eagerness and occasional vehemence which amused, but never offended, his interlocutors. His controversy with Archer Hinde over the *Timaeus* of Plato gave occasion for a display of fighting qualities which is still remembered in Oxford with sympathetic appreciation. He was not only a finished classical scholar, but also an accomplished mathematician; and to these attainments he added an unusually complete knowledge of German language, literature, and philosophy. One of the subjects to which he had devoted attention was the difficult problem of Greek music. On this he held views which did not coincide with those of many of the recognised authorities, in particular of the late Provost of Oriel, D. B. Monro. It must be confessed that he had his foibles; among them a somewhat deficient sense of proportion, especially in respect of time. But these in no way interfered with the regard in which he was held for the sterling worth and simplicity of his character. "The Cooker," as he was affectionately styled by his pupils and many of his colleagues, was an enthusiastic volunteer. He did much to keep alive the interest in military matters which in the days before the Boer war showed signs in Oxford, as elsewhere, of a dangerous slackening. He was practically the creator of the cyclist contingent of the O.U.V., and his manual of training for that body became a model for the cyclist service throughout the army. Many will remember "Das Kochmannslied," a piece of good-natured banter by H. W. Greene, of Magdalen, in which humorous reference was made to Wilson's military prowess, his famous manœuvre for the discomfiture of hostile cavalry, his "gyrotwistive Knasterbart," and his polemic with Archer Hinde. "Multis ille bonis flebilis occidit."

NOTES.

We are officially informed that Prof. H. B. Baker will be unavoidably prevented from attending the Manchester meeting of the British Association, and that, in his place, Prof. W. A. Bone will be the president of the Chemistry Section.

The following additional information has reached us with reference to the communications which may be expected to be made to Section B of the forthcoming meeting of the British Association:—Prof. P. Henry (Louvain), vinyl acetic nitrite; Dr. A. Hynd, configuration in the sugar group; Dr. Sand, a new cadmium vapour arc lamp; Dr. W. E. S. Turner, ionisation in solvents of low dielectric constant; Dr. Turner and Mr. Cauwood, molecular state of salts in solution; papers on flame and combustion, with experimental illustrations, probable contributors, Prof. Dixon, Dr. Wheeler, and Dr. Coward.

A munitions inventions branch of the Ministry has been constituted, with Mr. E. W. Moir as comptroller. The branch, which for the present is located in Armament Buildings, Whitehall Place, will have the duty of considering projects for inventions relating to munitions for warfare on land or matters appertaining thereto. The comptroller and staff of the branch will be assisted in their work of examination, and, if thought necessary, in the investigation and development of any projects that may be considered worthy of being developed, by a panel of honorary scientific and other experts. The following have accepted Mr. Lloyd George's invitation to act on this panel:—Col. Goold Adams, Mr. Horace Darwin, Mr. M. Duckham, Mr. W. Duddell, Dr. S. Z. de Ferranti, Dr. R. T. Glazebrook, Sir R. Hadfield, Dr. J. S. Haldane, Col. N. B. Heffernan, Sir A. Kennedy, Mr. F. W. Lanchester, Dr. A. P. Laurie, Prof. Vivian B. Lewes, Mr. M. Longridge, Mr. W. H. Maw, Sir Hiram Maxim, Capt. Moore, Sir H. Norman, Mr. F. G. Ogilvie, Major-Gen. G. K. Scott-Moncrieff, Mr. W. Stokes, Mr. J. Swinburne, Sir J. J. Thomson, Mr. A. J. Walter, Mr. C. J. Wilson. All communications should be addressed to the Comptroller at the address given above.

The President of the Board of Agriculture and Fisheries has appointed a committee (consisting of Lord Middleton (chairman), Mr. Henry Chaplin, Sir Ailwyn Fellowes, the Hon. Alexander Parker, Major Sir M. Burrell, Bart., Sir G. Greenall, Bart., and Capt. M. S. Adye) to consider and advise the Board as to the steps which should be taken to secure the production and maintenance in England and Wales of a supply of horses suitable and sufficient for military purposes, especially on mobilisation. Mr. E. B. Wilson, of the Board of Agriculture and Fisheries, has been appointed secretary of the committee.

It is reported from Stockholm that the Nobel prizes for the present year will amount to 8100*l.*, but that the distribution may be postponed. From next year the prizes will be reduced by 1125*l.*, representing the amount of the new Swedish defence tax.

The sum of 140*l.* has been given to the Royal Society of Arts by Mr. R. Le Neve Foster for the purpose of founding a prize in commemoration of his father, Mr. Peter Le Neve Foster, who was secretary of the society from 1853 to 1879. The council has decided to offer the prize (consisting of 10*l.* and the society's silver medal) for a paper on "Zinc: its production and industrial applications." Competing papers (which must be typewritten) must reach the secretary of the Royal Society of Arts by, at latest, December 31, 1915.

According to a Reuter telegram the Vienna Academy of Sciences has made a grant of 160*l.* to Prof. R. Poech to enable him to conduct anthropological researches among the various races comprising the Russian prisoners of war.

We learn from *Science* that Prof. W. H. Welch, of the Johns Hopkins University, and Dr. S. Flexner, of the Rockefeller Institute for Medical Research, are about to inspect and report upon the medical schools and hospitals of China, on behalf of the China Medical Board of the Rockefeller Foundation.

We see from *Science* that an expedition has been sent by the St. Louis University to study tropical diseases and biology in British and Spanish Honduras. The expedition consists of Dr. J. P. Coony, professor of chemistry; Dr. E. N. Tobey, instructor in tropical diseases; and A. M. Schwitalla, a student in biology.

We regret to announce the death of Mr. Robert Hammond, a short account of whose career is given in *Engineering* for August 13. Mr. Hammond was one of the pioneers of electric lighting in this country, and was the first concessionaire of the Anglo-American Brush Electric Light Corporation, Ltd. He was also associated with Messrs. Greenwood and Batley in the manufacture of electric machines, and put down the first works in this country in which current was distributed from a centre for lighting at high tension by incandescent lamps. Mr. Hammond put down electrical supply works in a great number of towns in this country and abroad. He was an ardent exponent of municipal trading; his services were often requisitioned as an expert witness. By reason of his kindly disposition and genial manner he established friendly relations with all with whom he came in contact, and his loss will be widely felt and deplored by his host of friends in all parts of the country. He contributed many papers for technical societies; in 1902 he succeeded the late Prof. Ayrton in the capacity of honorary treasurer of the Institution of Electrical Engineers, a position which he held until the time of his death. He was also a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers.

The death of Mr. Edwin Charles Carnt is announced in *Engineering* for August 13. Mr. Carnt took up active work in the firm of the late Mr. John S. White at Cowes in 1898, a time contemporaneous with the almost world-wide recognition of the immense potentialities of torpedo craft. His experience as an officer in the Navy, as a member of the engineering staff of the dockyards, and as an overseer in private works, together with his personal qualifications, marked him out as an appropriate engineering manager of such works as White's. The firm, under his dominating energy and wide practical experience, quickly stepped into and retained a high place among the constructors of high-speed light craft of all types. His death took place on the 5th inst.

We regret to have to record the death, on August 16, at the age of seventy-seven years, of Mr. F. Victor Dickins, C.B., who was registrar of the University of London from 1896 to 1901.

Particulars are given in the *Morning Post* of Monday last concerning Capt. E. Bage, of the Australian Engineers, who was killed in action at Kaba Tepe some weeks ago. In 1911 he joined Sir Douglas Mawson's Australasian Antarctic Expedition, making a record of tidal observations at Adelie Land. In the summer of 1912–13 Capt. Bage led his two comrades —F. H. Hurley (now serving with Sir Ernest Shackleton) and E. N. Webb (magnetician)—within fifty miles of the south magnetic pole. On the journey back to winter quarters they failed to find a food depôt, but got back to safety after nine weeks of great hardship. During the second year of enforced wintering Capt. Bage turned his attention to magnetic work and astronomy, and made further valuable additions to Antarctic science.

A Reuter message from Zurich states that the Laryngologists' Society has expunged the name of Sir Felix Semon from the list of its honorary members, the reason given being that, although Sir Felix was born in Germany, and studied in Vienna and Berlin, he wrote a letter to the *Times* expressing detestation of the barbaric methods of the Germans in the war.

The summer meeting of the Royal Cornwall Polytechnic Society will be held at Falmouth on August 31 and September 1 and 2, when the following communications will be made:—On August 31, "The Physical Condition of Cassiterite in Cornish Mill Products," by the late J. J. Beringer, further explained by W. H. Trewartha-James; on September 1, "The Occurrence of Tin and Tungsten in the West of England," by J. H. Collins; "Development of Mechanical Methods in China Clay Mines," by J. M. Coon; and "Prospects for Tin in the United States," by H. F. Bain. On September 2 a paper on "Piskies: a Folklore Study," will be read by H. Jenner, and a lecture on "The Fly Problem," delivered by F. Balfour Browne. A feature of the meeting will be a display of exhibits illustrating British articles of commerce previously either wholly or partly supplied by Germany and Austria.

The provincial sessional meeting of the Royal Sanitary Institute will be held at Brighton on September 3 and 4, when discussions will take place on Indian sanitation, camp sanitation, maternity and child welfare, and on the final report of the Royal Commission on Sewage Disposal.

When the Institution of Electrical Engineers has been able to arrange the various historical specimens of apparatus which it has collected for its museum, it will possess one of the most interesting collections of this character. The latest addition has been made by H.M. Queen Alexandra, who has given the institution a pair of Bell telephones presented to her in 1878, and made on board H.M.S. *Thunderer*. These instruments were actually used for conversation between the schoolroom and her Majesty's sitting-room at Marlborough House for a number of years. The Institution of Electrical Engineers is situated on Victoria Embankment, and it is therefore quite appropriate that it should possess the original Gramme dynamo used for the first experimental lighting of the Thames Embankment. There is also in the collection one of the Jablochkoff candles used in those days, and we believe that, to make this part of the collection complete, one of the holders employed for these would be welcome. One of the most recent additions is a Holmes magneto-electric generator, which has worked the lamps at the Sowter Point lighthouse continuously since 1870 until only two or three years ago, and the Gramme dynamo which lighted the *Daily Telegraph* offices in 1882 is also in the possession of the institution. Another relic, but of more recent historic interest, is the set of telephones employed on the Scott Antarctic Expedition.

THE Board of Education has issued a circular stating that an urgent request has been received for books for the use of the British civilian prisoners at present interned in the concentration camp formed on the racecourse at Ruthleben, Germany. The books are needed by the educational classes in connection with the Camp Education Department, which has recently been formed for the benefit of the prisoners in question. The Board of Education has sanctioned the issue of an appeal for books of the kind specified in the circular above referred to. As the number of books which can be sent to Ruthleben is limited, it will be well for intending donors to apply for a copy of the circular (which gives the titles of the works needed) to Mr. Alfred T. Davies, Board of Education, Whitehall, S.W., writing in the left-hand corner of the envelope "Books for Ruthleben." We may mention that lectures have been delivered by the Arts and Science Union of the camp on the following among other subjects:—Conic sections, differential and integral calculus, inorganic and organic chemistry, human physiology, psychology, electro-chemistry, agricultural chemistry, genetics and eugenics, mechanics and hydrostatics, physics, radio-chemistry, technical chemistry, general technology (popular), archæology, photography. The lecturers will be grateful for reference works in these subjects. Dictionaries and scientific periodicals would also be most valuable.

THE war has stimulated research in preventive and curative medicine, and announcements of the discovery of various new remedies and methods of treatment appear from time to time in the public Press. Thus the preparation of a new "polyvalent" serum, presumably made with a mixture of microbes, for the treatment of infected wounds is recorded, and for which extraordinary powers are claimed. The discovery is due to the labours of Profs. Leclainche and Vallée, of the Veterinary College of Alfort. It is also stated that Dr. Bull, of Melbourne, has found in eucalyptus a cure for cerebro-spinal fever. Details of a "new" antiseptic mixture for the treatment of wounds similarly found a place in the daily papers last week. This consists of a mixture of chlorinated lime (bleaching powder), boric acid, and chalk, but, as the *Lancet* points out, the claims to novelty for this antiseptic are ill-founded.

OF all manuals of good advice to the soldier, "Health in the Camp: A Talk to Soldiers," by Col. H. R. Kenwood, is one of the best. It is published by H. K. Lewis and Co., Ltd., London, and it costs threepence. Col. Kenwood, being professor of hygiene and public health in the University of London, and an officer of the Royal Army Medical Corps, writes with authority. Moreover, he writes well, with perfect simplicity, and with some distinction of style; and he takes, as it were for a text, the plain fact that "the obedient and intelligent co-operation of every single soldier is demanded, if the sanitation of the camp is to be what it ought to be." We wish the little book were twice as long as it is. What he says of camp sanitation, and of the vital importance of clean food, pure water, and fresh air, is admirably well said. There is a good short account of the protective treatment against typhoid fever; and there is a very valuable note on the venereal diseases. Of course, sixty small pages are not enough; but he makes every word tell, and seems to have a word or two for every subject of chief interest. He avoids the mistake of throwing a list of names of things at the reader's head; and he does not let diagrams take up room, where every inch is needed for print. In brief, here is an excellent little tract for the soldier, whether in training or at the front.

"PRACTICAL Advice on the Fly Question" has been issued by the Zoological Society of London at the price of one penny. It is apparently an "official" summary of advice based on the inquiries conducted under the society's auspices, and intended to have the authority of the society. The pamphlet is devoted entirely to practical advice on how to deal with flies, how to keep them from food, how to keep them out of the house, how to catch them; it deals with the breeding of flies, the treatment of stable manure and refuse; it ends with a summary of measures recommended for private houses, for the country, for refuse tips, for stable manure, for hospitals, camps, shops, and food factories. Flies are undoubtedly important, both to the nation at large and to the miltary authorities; it is characteristic of this nation that such advice should issue from a private society, rather than from either of the Government departments the business of which this should be. The pamphlet is clearly based upon experience of dealing with flies and upon elaborate investigation on new points; the advice is given in a clear and practical manner. To those who visit the Fly Exhibition, as to all who are interested in the house-fly, this little publication should be of use.

IN the Journal of the Gypsy Lore Society, vol. viii., part i., Mr. A. Russell publishes a useful glossary of Scoto-Romani and Tinklers' Cant. Early collections of this dialect are wanting, and even the interpretation of some words found in Scottish documents of the sixteenth century is doubtful. At an early period the Scottish Romani was amalgamated with that of the Tinklers, a nomad class whose origin is still a puzzle. The most interesting words in the collection are those which have survived in the Scottish-Gypsy dialect, but have been lost in the English. There is also a difference in word forms, which has been explained by the supposition that the majority of English Gypsies of the present day are descended from a later immigration than that of those who left their mark on the Tinklers' Cant of Scotland, though the variation in vowel sounds may be partially due to the influence of local English dialects.

Drs. J. C. Costerus and J. J. Smith continue their studies in tropical teratology in the Annals of the Buitenzorg Botanic Gardens, 2e Series, vol. xiv. Several interesting cases of malformations are described and figured, especially in ferns, palms, and orchids. Among the most interesting are two germinating coconuts. In one, three stems are sprouting from a single nut; two stems from a nut have been recorded before, though such cases are not more than one in a thousand, but the present case is one out of forty thousand, and is probably unique. The phenomenon is no doubt due to polyembryony. The other, and more remarkable, case is that of the premature flowering of a germinating coconut. The young plant had produced eleven leaves, the blade of the biggest being 56 cm. long, and a terminal inflorescence bearing both male and female flowers, the latter being at the base, as is normal. Dr. Costerus has previously noticed similar cases of premature flowering in Melia and Tectona (Ann. Jard. Bot. Buitenzorg, vol. ix., p. 115).

The number, vol. i., No. 8, issued June 22, of the Gardens Bulletin, Straits Settlements, is devoted to a paper on the Para Rubber Trees in the Singapore Botanic Gardens, by the director, Mr. I. H. Burkill. A detailed account of the treatment the trees have received is given, and a very good series of figures illustrate the methods of tapping adopted. The publication of the details of latex-yield will be of great service in determining which trees are the best latex-yielders, and which, therefore, should be used as seed-bearers for the raising of new stock. It is well known that variability is found in the latex-yield of trees in Brazil comparable to that noted in plantation trees. A large map of the rubber ground at Singapore has now been prepared, so that full details of each tree can be accurately noted. A carefully compiled history of the introduction of the Para rubber tree to the Straits, and an account of early tapping records, occupies several pages of this useful paper.

In an interesting paper entitled "Observations on the Study of Plant Pathology," reprinted from the *Journal of Economic Biology*, June, 1915, vol. x., Nos. 1 and 2, Mr. G. Massee considers generally the subject of plant pathology. He points out that the leading idea in dealing with cultivated plants is to intensify or develop to an abnormal extent either the flowering, fruiting, or some other desirable quality, and in so doing there is a marked tendency to upset the physiological balance of the plant and open the door to the spread of disease. A general discussion of the different types and modes of attack of the various parasitic fungi is followed by some reflections on the training needed by anyone who desires to be a competent plant pathologist, and it is very justly pointed out that a sound knowledge of cultivation and of plant physiology is an essential part of the training. The remark that "the scientific standard of plant pathology, in this country at least, is little above that of spraying to check disease, which is useful in proportion to the benefit derived therefrom," is no doubt partially true, but Mr. Massee appears to forget that a good deal of work is being done in investigating the resistant powers of plants, in the breeding of disease-resistant forms, and in attempting to discover the factors which underlie the susceptibility of plants to disease.

A further instalment of "Materials for a Flora of the Malayan Peninsula" has just been issued, and is reprinted from the Journal and Proceedings, Asiatic Society of Bengal, vol. lxxv., part iv., 1915. The part before us, No. 25, contains the families Cytinaceæ and Balanophoraceæ, from the pen of Mr. H. N. Ridley, while the Juglandaceæ, Myricaceæ, Casuarinaceæ, Fagaceæ, and Salicaceæ, by Mr. J. S Gamble, occupy sixty-eight out of the seventy-five pages of the instalment. One new species in Balanophoraceæ and eight in Fagaceæ are described. The oaks are particularly interesting, three species of the genus Quercus, a typically northern hemisphere genus, being found in the mountains of Malaya, while there are thirty-five Pasanias and thirteen species of the closely-allied genus Castanopsis. Pasania is a genus confined to Malaya and the Pacific Islands, and the distribution of Castanopsis is remarkable since one species inhabits North America and the rest belong to tropical or subtropical Asia.

The *Gardeners' Chronicle* for August 14, 1915, contains a well-written article on the Island of Java, dealing especially with the cultivated products, the more important of which are rice, sugar-cane, tobacco, coffee, leguminous crops, and cassava. Good photographs of terraced rice fields in a valley, of the planting of rice in irrigated fields are given. As in the East generally, the agricultural work is mainly done by hand, and mechanical means for carrying out tillage are few. The Dutch are at present engaged in providing a system of education for the natives which the writer of the article considers may prove to be of doubtful value, since it cannot easily be made suitable to local conditions.

Prof. Shirasawa describes some new species and varieties of Picea and Abies in the *Gardeners' Chronicle* of August 14. They are *Picea koyamai*, a new species discovered in 1911 on Mount Yatsugatake, in Shinano province, at 1500–2000 m., where it forms a pure stand in the midst of a forest of *Larix leptolepis*. On the same mountain occurs the new variety, *acicularis*, of *Picea bicolor*, Mayr, which has a very limited distribution. Another variety of this species, var. *reflexa*, distinguished by the broad and reflexed apices of the cone scales, is found in the valleys of the Oi and Haya rivers, Central Japan. *Picea maximowiczii*, now a rare spruce, rising to 50 m. in height, was discovered two years ago on the mountain ranges of Shinano province, its native place having been unknown, and a new variety, *olivacea* of *Abies vietchii*—distinguished especially by its olive-grey cone—from the higher mountains of Central Japan, are also described. The account is illustrated by a set of useful figures.

The *Madras Fisheries Bulletin*, No. 8, 1914, contains two interesting papers by Mr. James Hornell. The first of these is an account of fishery experiments made by an English steam trawler in 1907 for the Ceylon Company of Pearl Fishers, Ltd. The company has now ceased to exist and the results of the experiments are published. There is very little good trawling ground off the coast of Ceylon on account of the extensive areas of bottom covered by corals, etc. Off Cape Comorin, to the west, south, and east, an area of no less than 4000 square miles within the 100-fathom line was investigated. All of this was good trawling ground. Two tons of fish could be obtained per day's working. The other paper discusses the irregularly cyclic nature of the Ceylon and Indian pearl fisheries. It is well known that there are periods of productive years, two to six in duration. These are followed by periods up to twenty-seven years in duration during which the fishery fails absolutely. The cause of the sterility is the destruction of the growing pearl oysters by predatory fishes. An abundant deposit of oyster spat is soon followed by a great increase in oyster-feeding fish, and after a year or two the latter gain the ascendancy. The grounds then become almost absolutely denuded of oysters. Afterwards they are again planted with spat from irregularly distributed reproducing oysters, it may be at very considerable distances away. The distribution of spat on suitable grounds depends on a number of conditions, and it is relatively seldom that all of these are satisfied at the same time. The barren periods are therefore of much longer duration than the fertile ones. Only by artificial culture of the pearls can a permanent fishery be expected, since it is apparently hopeless to attempt to counteract the destructive action of the predatory fishes.

ORNITHOLOGISTS will be glad to know that, in the *Scottish Naturalist* for August, Mr. John S. Tulloch makes a brief announcement of the fact that the gannet (*Sula bassana*) is extending its breeding range, four nests having been found on the Noup of Noss, Bressay. This record apart, only fifteen breeding stations of this bird are known, and of these nine are British. The only English station, Lundy Island, has of late years been forsaken owing to the merciless persecution to which the birds were subjected. Wales has one station, Grassholme, off Pembrokeshire; Ireland two, the Little Skelling, Co. Kerry, and the Bull, off Co. Cork. Scotland has five stations, all, save the Bass, on the west coast. All these stations, it is to be noted, are islands, the gannet nowhere ever breeding on the mainland.

MR. J. H. GURNEY and Miss E. L. Turner contribute some extremely interesting "Notes on a Long-eared Owl Nesting on the Ground in Norfolk" to the *British Birds Magazine* for August. Inasmuch as there were suitable trees in the neighbourhood, it is curious that the nest should have been made, as it was, in a slight depression on the ground in the middle of a small plantation. Of the five eggs which the nest contained, but three hatched. Miss Turner gives some beautiful photographs of the female brooding her nestlings, which add greatly to the value of this unusual record.

SOME new species of ectoparasitic trematodes are described in the June number of *Zoologica*, a publication issued by the New York Zoological Society. Among these is a quite remarkable new genus represented by two species. One of these, *Atalostrophion sardae*, infests the mucous membrane of the branchial cavity and the thyroid glands of the Bonito (*Sarda sarda*). So far no perfect specimen of an adult worm has yet been secured, nor does it seem likely that this will ever be done. And this because, in the sexually mature state, the body, which is about 6 in. long, and exceedingly fragile, is coiled in tangled masses among the tissues in which it lives, and since broken ends are always found when the specimens are examined *in situ*, it is to be assumed that it is natural for the worm to disseminate its eggs by throwing off the parted sections. Two complete specimens of imperfect worms have, however, been secured, and these have been of the greatest service in determining the details of the anatomy of the adult, of which the largest fragments so far obtained have not exceeded 3 in. in length. The other species was obtained from the gills of a large Jew-fish (*Promicrops guttatus*). This differed from that just described in being more muscular and less delicate. Sufficient material, however, has not yet been secured to enable a full diagnosis of its specific characters to be made.

THE March number of *Terrestrial Magnetism and Atmospheric Electricity* contains a report by Dr. W. F. G. Swann on the atmospheric electrical observations taken during the cruise of the *Carnegie* from Brooklyn to Hammerfest, Spitsbergen, Iceland, Labrador, and home in the summer of 1914. The average value of the vertical potential gradient was 93 volts per metre, with a general increase in the value from summer to winter. The value agrees with the 80 volts per metre found by Simpson and Wright over the South Atlantic in 1910. The electrical conductivity of the air due to both positive and negative ions was 2.52×10^{-4} in electrostatic units, and increased to a maximum in September, in agreement with the results found previously for the Atlantic. The average value of the earth-air current was 7.7×10^{-7} electrostatic units per sq. cm. The radio-activity was, on the average, 23, in Elster and Geitel units, and corresponds to 12×10^{-12} curies of radium emanation per cubic metre. Some of the decay curves suggest the presence of thorium-B. None of the electrical elements observed showed any marked variations with temperature or fraction of saturation of the atmosphere.

IN his paper on the equations of motion of a plane-kite (Bulletin of the Calcutta Mathematical Society, ii, 1, pp. 25 *et seq.*, now reprinted with additions), Prof. J. M. Bose has broken valuable ground on one of the many unsolved problems of aeronautical rigid dynamics. The assumptions on which the investigation is based lead to cubic equations for symmetric and lateral stability, instead of the biquadratics obtained for the aeroplane. This appears due to the author's assumptions (1) that the kite is a plane surface without dihedral angles or keels, (2) that the line of action of the tension of the string meets the plane of the kite in a fixed point. Mr. C. V. Raman raises valid objections to the second assumption, which certainly does not hold good if the string is forked where it is attached to the kite, as shown in Prof.

Bose's figure. We have made the necessary additions, and find a biquadratic, as was anticipated. But a more unfortunate circumstance is that the author makes the variations in the components of the tension of the kite string depend on the velocity components of the kite instead of on the angular displacements. It is to be mentioned, however, that the investigation is independent of the assumption that the surface of the kite is a narrow plane gliding at a small angle of attack, an assumption sometimes justifiable in the case of an aeroplane, but inapplicable to the old-fashioned quadrilateral kite.

The *Psychological Bulletin* for June 15 contains several summaries of recent work in the different departments of sense perception. One of them deals with the factors which influence the estimation by an observer using one or both ears of the position of the source of a regular sound such as a musical note. For a person using one ear only Arps and Klemm have confirmed the belief that some factor besides the intensity of the sound heard plays a part in the estimation of the distance of the source. Myers has shown that the timbre of a note is one of the factors which affects the estimation of distance of a source in the hearer's median plane, but not in any other direction. Another summary deals with optical illusions, amongst others with that of two or more parallel lines, one of which when crossed obliquely by short lines no longer seems parallel to the others —Zöllner's lines. Giese has shown that if one line only of a pair of parallel lines is crossed by oblique lines, the extent of the illusion is half that when both lines are crossed when one eye only is used, but that when both eyes are used the illusion is the same in each case. If the figures are presented in succession instead of simultaneously, the extent of the illusion is diminished. Practice also decreases the illusion.

OUR ASTRONOMICAL COLUMN.

August Meteors.—Mr. Denning writes:—"Very unsettled weather, with thunderstorms unusually prevalent, has interfered with observation of the Perseids this year, but a fair number of them were recorded. The display appears to have been one of average character.

"On August 10 the sky was only partly clear at some places. There were about 20 meteors per hour (14 Perseids) for one observer watching uninterruptedly.

"On August 11 clouds were more abundant, and not much could be seen of the shower.

"On August 12 the sky was very favourable in the west of England, but somewhat clouded in the east. At Bristol 80 meteors (68 Perseids) were seen up to 12.30 p.m., but many others were missed, and the horary rate for a constant watch of the sky would have been about 40.

"On August 13 there were some passing clouds, but up to midnight these did not materially affect the progress of observation. At Bristol 45 meteors (29 Perseids) were counted. The number had evidently decreased since August 12.

"On August 14 several thunderstorms occurred during the night, and nothing could be seen.

"The radiant point of the meteors was as follows:—

July 15	$15^\circ + 48^\circ$
August 10	$40 + 55$
August 12	$47 + 58$
August 13	$49 + 58$

Nearly all the meteors left streaks.

"The most brilliant object appeared on August 13 11h. 8m., shooting from $34\frac{1}{2}^\circ + 50^\circ$ to $25\frac{1}{2}^\circ + 45\frac{1}{2}^\circ$, where it left a streak for 30 seconds as seen from Bristol. It was seen at Bristol, and by Mrs. Wilson at Harrow. Its radiant point was at $54^\circ + 56^\circ$, and height 79 to 55 miles, path 48 miles, and velocity 40 miles per second. It moved from over Northampton to Oxford.

"A curious meteor was recorded on August 12 10h. 44m., shooting upwards from $30\frac{1}{2}^\circ + 20^\circ$ to $13^\circ + 51^\circ$. It moved slowly, and left a bright streak. Half-way along its course it appeared to stop, and then renewed its course.

"The radiant of the Perseid swarm was fully four degrees in diameter.

"Large meteors were not very abundant, but several were noticed, and will be made the subject of further investigation. Several of them were recorded by two or more observers.

"Mrs. Fiammetta Wilson at Harrow-on-the-Hill, and Miss A. Grace Cook at Stowmarket, obtained a number of valuable observations, though the atmospheric conditions were seldom very good. It will be possible to compute the real paths of many large meteors (Perseids) and of several meteors directed from the minor radiants of this period. Mrs. Wilson, with her usual perseverance, has sent the writer a list of 110 meteor-paths observed from August 7 to 15.

"One of the most interesting objects that has appeared during the recent display was a brilliant one from Musca ($40^\circ + 29^\circ$) on August 10 at 9h. 33m. The meteor had a long path of about 154 miles from over London to the English Channel east of Start Point, Devonshire. It fell from a height of 68 to 52 miles.

"A feature noticed in regard to the Perseids was that they exhibited a distinct difference of velocity. This was quite apart from such discordances as might be induced by differences in position and distance. Two meteors appearing in very nearly the same region gave in several instances an apparent speed essentially dissimilar, though presumably at same height, or very nearly so."

The Detroit Observatory.—We have received vol. i., pp. 73–206, of the Publications of the Astronomical Observatory of the University of Michigan, which forms an impressive testimony to the activity of the staff. Thus, in about four years, no fewer than 3200 spectrograms have been secured with the $37\frac{1}{2}$ in. reflector, and meanwhile the Director has found time to organise and direct the work of the La Plata Observatory, which has already made a mark in cometary discovery. The long-projected Lamont 24 in. refractor, it is to be regretted, is still delayed, awaiting the delivery of the flint glass disc from the Jena makers.

The astronomical researches described in the present volume include determinations of the geographical position of the observatory, the visual light curve of β Lyræ, a paper on the characteristics of Cepheid variables, and studies of the spectra of δ and ϵ Orionis, all the work of Prof. Ralph H. Curtiss; the spectra of ψ Persei and β Monocerotis, and radial velocity of Maia, treated by Dr. Paul Merrill; a study of the titanium spark as a comparison spectrum, by Mr. Lewis L. Mellor; and observations of double stars discovered at the La Plata Observatory (13th Catalogue), by Prof. W. J. Hussey. Numerous observations of comets, including comet Daniel (1909*a*) and of some minor planets, are also published. The preceding part (pp. 1–72) of the volume was noticed in NATURE, vol. xci., p. 67, March, 1913.

OCCULTATION OF β SCORPII BY JUPITER (1876).—The Bulletin of the Astronomical Society of Barcelona (vol. iii., No. 6) contains an article by Senor Vicente Ventosa, of the Madrid Observatory, describing observations he had the good fortune to secure of an unpredicted *occultation* by Jupiter of the brighter component of β Scorpii on February 27, 1876. In the Nautical Almanac for 1876 this conjunction was given as a very close approach with the star, 0° 1′ N. Jupiter was obscured by clouds when the occultation commenced, and when observations were possible β_1 was invisible and emersion was witnessed. This conjunction was referred to in NATURE, vol. xiii., p. 188, and described by Mr. J. Birmingham in the same vol., p. 368. Senor Ventosa, by making use of Coniel's corrections to Bouvard's tables of Jupiter, has calculated the circumstances of the occultation, and from his observations of the variation of magnitude of the star as it left the limb obtains a probable height of 2500–3000 km. for the Jovian atmosphere. An extended account of the research is to be published in the Revista of the Royal Academy of Sciences of Madrid.

THE FIGURE OF THE EARTH.—Many books have been written on this subject, yet the current literature is so comparatively inaccessible to non-specialists, and such meagre statements are generally given in textbooks, that there must be many persons ready to welcome the authoritative essay by Prof. W. de Sitter in the August number of *The Observatory*. In directing the attention of our readers to this article, we may add that Prof. de Sitter comes to the conclusion that to improve our knowledge of the figure of the earth we must observe minor planets, and that the opposition of Eros in 1931 will afford the earliest opportunity. It will no doubt be recalled that last year Prof. E. W. Brown, in his opening address to the sub-section of Cosmical Physics of the British Association, stated that direct observations of the moon's parallax are likely to furnish at least as accurate a value of the earth's shape as any other method.

METEOROLOGY OF THE MOON.—An extremely interesting article under this heading appears in *Popular Astronomy* (No. 3, 1915), contributed by Prof. William H. Pickering. It is largely the outcome of some two and a half years' observations, for which the Jamaican station of the Harvard Observatory has evidently proved highly satisfactory. Details are given of changes observed in selected types of lunar surface, elevations, depressions, and level areas. The changes are given as being typical of what is everywhere taking place. A series of drawings of the lunar mountain Pico is reproduced. All the recorded changes are held to fit in with the hypothesis of snow or ice formation, or the reverse. The article successfully makes obvious that our satellite still offers a most fruitful field to zealous and patient work.

R CORONÆ BOREALIS.—This irregular variable is apparently undergoing one of its more or less sudden failures of light. Prof. A. A. Nijland (*Ast. Nach*, 4809, 184) reports that whilst for $2\frac{1}{2}$ years it has been constant at about 6·4m., on July 24, as estimated in opera-glass, its magnitude was 7·1, and on July 29 only 7·6. We find that Prof. Nijland observed secondary minima during the preceding light fluctuations on March 8 and May 13, 1912, the star then fading to 10·2m. and 8·2m. respectively.

THE PRETORIA MEETING OF THE SOUTH AFRICAN ASSOCIATION.

THE South African Association for the Advancement of Science held its thirteenth annual session during the first week of July, at Pretoria, under the presidency of Mr. R. T. A. Innes, Union Astronomer. Notwithstanding the war, festivities and excursions took place as usual, and not the least interesting and instructive of the latter were visits to the Government School of Agriculture at Potchefstroom, to the Bacteriological Research Laboratory at Onderstepoort—said to be the finest institution of its class in the world—and to the 2100 ft. level of the Crown Mines near Johannesburg, which has subterranean galleries extending over an aggregate of 100 miles. It so happened that, on the very day when the news of the surrender of German South-West Africa was received, Mrs. Botha had arranged to visit the association in session at the Transvaal University College; she was accorded a great ovation, after which the members sang the National Anthem.

The papers read numbered nearly eighty, and outlines of some of them, as well as of the four sectional presidential addresses, are given below.

The presidential address given before Section A by Mr. F. E. Kanthack, director of irrigation of the Union, was a historico-scientific account of the development of the internal-combustion engine, the development of which is probably the greatest engineering feat the world has ever seen. This factor in the war is entirely novel, and has had more far-reaching effects than anything else. It is scarcely possible to realise and appreciate the enormous amount of scientific work and inventive genius which has been expended on the motor-car, and especially on the engine. New metallurgical processes had to be invented to produce steels of great strength to survive the shocks and strains of hard-running, and the various machine tools and manufacturing processes connected with motor-car construction are no less wonderful than the finished article. What the steam engine was to the nineteenth century the internal-combustion engine is to the twentieth, and the effect of the latter on society is probably greater and more far-reaching than was the case with the steam engine.

The president of Section B, Mr. H. Kynaston, director of the Union Geological Survey, died during the week preceding the association's meeting, and his address was read by the sectional secretary after a vote of condolence had been adopted. Its theme was "Radio-activity in its Bearing on Geological Problems." The address referred to the significance of the results regarding the concentration of radio-active compounds, although the data are as yet scarcely sufficient for definite conclusions. The view was expressed that either radio-active elements are absent from the more central portion of the earth, or present to an inappreciable extent, or else some agency such as pressure is able to restrain radio-activity in depth, or altogether prevent atomic disintegration. As the latter alternative does not seem to conform to observation, it would appear that radio-active elements are confined to the crustal portion of the globe. The address then went on to discuss the bearing of meteorites on the idea of a radio-active crust, the conclusion being that the evidence certainly lends support to that theory.

Section C also had to meet without its president, Mr. C. P. Lounsbury, chief of the division of entomology of the Union, who, convalescent from an illness which narrowly escaped being fatal, had left South Africa on a six months' tour in Australia and the United States. His address was a discussion of some phases of the locust problem. The author expressed the opinion that the Union is entering upon a cycle of years when locusts will be widespread and destructive. The species of locusts that periodically ravage South Africa were described, the principal being the red and the brown locust, the former being congeneric with the large North African locust and that of the Argentine, while the brown locust is congeneric with the migratory locusts of Europe and Asia. The effects of climatic conditions on locust migration were discussed, as well as the causes of the excessive multiplication. The concluding paragraphs of the address dealt with the enemies of the locust.

In Section D the presidential address was delivered by Mr. J. E. Adamson, Director of Education of the Transvaal; its subject was "The Control of Education," and it laid down the principle that the control of school education should henceforth be vested in the Central Government of the Union and not in the executives of the provinces. It was, he said, a dictate of the national conscience; moreover, national education is a vital factor of national progress, and, in addition, national schools should reflect national aims and aspirations. That there was divergence in South Africa regarding these aims and aspirations was only a further reason for discussing them in a national assembly. Wise and impartial administration would only be secured if it were in the hands of a body representing wide and varied interests.

With regard to the papers read at the various sectional meetings only brief summaries can be given. In Section A Mr. A. H. Reid contributed a useful review of the leading classes of fire-resisting materials used in building construction, while from the naval engineer's point of view Mr. H. C. Kenway discussed certain aspects of modern naval development. The president of the association, in a paper on the masses of visual double stars, gave a table containing all double stars for which fairly trustworthy orbits had been computed. Dr. A. W. Roberts had a paper on secular change in the period of μ Carinæ, the variation of which star was discovered at Lovedale in 1891. The discrimination of the conic by Prof. Dalton, and the gamma, or factorial function, by Prof. Roseveare, were types of the heavier mathematical papers read in the section. Mr. E. Jacot, discussing the measurement of the natural ionisation of the air, contrasted the results obtained by the Gerdien and by the Ebert forms of apparatus, and showed that these results are not comparable.

In Section B Prof. J. A. Wilkinson, in a paper on "The Profession of Pharmacy," urged the need of reform, and pointed to the fact that South Africa as yet offers no pharmaceutical training in any of her colleges, and that materia medica and toxicology are nowhere taught. A paper on the Rand gold, by Prof. E. H. L. Schwarz, discussed the three classical theories as to the origin of the gold, and expressed his preference for the placer theory. Another contribution by the same author had for its subject "The Fault Systems of the South of Africa." Dr. W. A. Caldecott read an important paper entitled "Some Features of the Rand Gold Mining Industry," in which he set forth the main results of the operation of the Witwatersrand gold mines during the past twelve years. Dr. C. F. Juritz, in a paper on the chemical composition of Karroo ash, directed attention to the fact that large quantities of burnt sheep manure had accumulated throughout the Union during many years, and contained up to 19 per cent. of potash, 36 per cent. of lime, and 6 per cent. of phosphorus pentoxide. An interesting paper on the ! Naras plant (*Acanthosicyos horrida*) was contributed by Dr. W. Versfeld and Mr. G. F. Britten, describing the nature of the plant and its edible fruit, which is either consumed as gathered, prepared as soup, or made into cakes. Analyses were given of the fruit and of soils where the plant grows, and where it refuses to grow. Mr. A. Stead contributed a paper on the ash of the "alkali bush," in which he found 32 per cent. of potassium carbonate and 19 per cent. of sodium carbonate.

In Section C Prof. Schönland criticised Lotsy's theory of evolution, which, he declared, has not brought us a step nearer the *vera causa* of evolution. Mr. R. W. Thornton, principal of the Middelburg School of Agriculture, treated of the ostrich feather industry in South Africa, covering briefly, in addition to an historical introduction, the subjects of incubation, rearing, parasitic diseases, and feather marketing. An exhaustive analysis of South African agriculture was submitted in a paper by Mr. P. J. du Toit, Acting-Secretary for Agriculture of the Union, and it showed the marvellous agricultural progress of the country during late years, particularly since 1905. Mr. J. Burtt-Davy contributed a paper on his experiments in cross-breeding Persian and Merino sheep. Of the thirty-six papers submitted to Section C, only two can be adequately summarised here. These are Dr. A. L. Orenstein's paper on prevention of malaria, and Dr. Watkins-Pitchford's on miners' phthisis.

Dr. A. L. Orenstein read before Section C a paper on the problems and principles of malaria prevention, in which he outlined the following five lines of attack:—(1) The elimination of human carriers only; (2) the reduction to a non-infective minimum of the number of anophelinæ of the species capable of transmitting malaria; (3) the protection of the individual against the bites of mosquitoes; (4) the protection of the individual by proper medication against the development of the parasites within the blood; and (5) a combination of several or all of these methods. Of these methods the first is fraught with almost unsurmountable difficulties, the second method being the plan most generally acknowledged to be the most promising of results. Dr. Orenstein described malaria prevention as a highly specialised field of sanitation, and any large-scale scheme as a costly undertaking which should only be entrusted to specialists in this branch.

Dr. Watkins-Pitchford's subject was "Miners' Phthisis on the Rand." He emphasised the not generally recognised distinction between pulmonary silicosis and miners' phthisis. Silicosis due to the inhalation of air containing fine particles of quartz, etc., was rarely fatal; it became the much more serious disease, miners' phthisis, when the damaged lung became infected by the tubercle bacillus. The suppression of the disease would be obtained by action in two directions: preventing the inhalation of dust by workers in the mines, and excluding from the mines all those who were expectorating the tubercle bacillus. The proposition of abolishing miners' phthisis from the Witwatersrand he considered quite feasible, provided always that both the workers and the management co-operated in the common cause.

Dr. C. L. Leipoldt, medical inspector of schools for the Transvaal, in a paper read before Section D, stated that the percentages of men of the burgher commandos of the Transvaal province rejected for preventable and remedial defects were far higher than they were in conscript armies in countries where medical inspection of schools had been in vogue for years. It was clear that a large percentage of the adult population suffered from remedial and preventable diseases, which appreciably affected their wage-earning capacity and consequently the national efficiency. He suggested that school medical inspection should be linked up with the enforced inspection of at least all males between the ages of sixteen and forty-five years by qualified defence force officers.

In Section D one of the most attractive papers was undoubtedly that by Mr. E. C. Reynolds on the economics of the war, for the purpose of hearing which all four sections of the association combined. As at last year's meeting, some of the most interesting papers in this section were those dealing with phases of the native question. Such were two papers by the Rev. Noel Roberts on the initiation rites of the Bapedi, and on the traditional history of the Bagananoa. The Rev. W. A. Norton had a delightful little paper on African native melodies, all of which, he said, were in the pentatonic scale. The Rev. S. S. Dornan contributed a paper on Rhodesian ruins and native tradition. The author holds that the ruined towns were built by the men whose descendants still live in the country, and at no very distant date. The Rev. J. R. L. Kingon, of the United Free Church Mission at Tsolo, contributed a paper showing that native agriculture is on the threshold of a marvellous expansion, which only awaited the opening up of communications, towards which the Native Council had contributed 28,000*l.* during the last year. Another paper by the same author dealt with the economics of the east coast fever. Proportional representation was the subject of papers by Dr. J. Brown and Mr. R. Kilpin, and "Problems of Physical Continuity" were discussed by the Rev. Dr. S. R. Welch. The Rev. C. Pettman contributed to this section one of his instructive discussions of the origin of South African place-names, in the course of which he reviewed the commonly accepted derivations of such names as Bloemfontein, Algoa Bay, Walfisch Bay, and Slackhers Nek.

Dr. E. T. Mellor gave an evening lecture on the gold-bearing conglomerates of the Witwatersrand, in which he outlined briefly his own theory of the original deposition of the reef conglomerates. This was to the effect that what is now the Witwatersrand was once the deltaic mouth of a river, and that the gravels were deposited here in beds at different times and in slightly different localities. The extent of this delta would be fairly small compared with the extent of the present Ganges delta.

The most interesting function of the session was the award of 50*l.* and the South Africa medal, founded by the British Association in 1905, for scientific research in South Africa, to Mr. C. P. Lounsbury for his entomological investigations. In the absence of Mr. Lounsbury the president, at the conclusion of his inaugural address, enumerated the various pieces of scientific work engaged in by the recipient since he took up his residence in South Africa in 1895, and presented the medal to Dr. C. F. Juritz, to hold in trust until Mr. Lounsbury's return to the country.

TROPICAL DISEASES: STATISTICS AND RESEARCH.[1]

In reviewing these reports for 1913 we directed attention to the ambiguity involved in the term "Deaths ascribed to fever." Strictly speaking, the term fever should include all disease in which fever is a marked feature, *e.g.* not only malaria, but also enteric, pneumonia, etc., but whether it does so here appears to us to be uncertain. In the Hong-Kong report the heading is changed to "Deaths ascribed to malarial fever," and in the Straits Settlements it is subdivided into "unspecified fever," "malaria," "typhoid," and "dengue." In the returns for Government hospitals the heading does not occur. There surely must be cases in hospital of fever which are not comprised in the four fevers scheduled. If so, they should be returned. Again, under "Estates employing indentured labour" only "deaths ascribed to malaria" are returned. Surely, again, there must be many cases of fever which are not malaria. Why not return these also unless here malaria is synonymous with fever? This ambiguity then continues. A great advance in the statistics of malaria would be made if the diagnosis "fever" were not accepted as the equivalent of malaria. Everyone knows, for example, in India that "thousands" of cases are returned as malaria on no better evidence than the statement of the patient that he is suffering from "fever"; and so one may feel strong doubt as to the figures recorded in this report under the heading, "Attendances for malaria." (Why malaria and not "fever"?)

[1] Report of the Advisory Committee for the Tropical Diseases Research Fund for the Year 1914. (London: Wyman and Sons, Ltd.)

We repeat what we said last year, that parts of this statistical schedule require careful revision if it is to be of value. To note another statistical point. It cannot be too thoroughly appreciated that accurate population data must form the basis of practically all statistics of disease. Yet in the Mauritius report whereas the number of deaths for certain towns and districts is given, there is most unfortunately no corresponding population given. We might as well be given the number of deaths in India and Ireland and be left to draw our inferences without knowing the respective populations.

Before leaving these matters we would refer to the Southern Rhodesia Report, where a chart of the mortality and distribution of malaria, blackwater fever, and the rainfall for 1913 is given. By itself this is of no great value. Had the data for the ten years 1904–13, which appear to be available, been given, it is probable that definite conclusions could have been drawn.

We would repeat that if these statistics are to be of value in the future more care must be taken in their compilation. It is often said that "statistics lie." We do not believe they do, and that they cannot if only we know exactly what they represent.

Turning next to the appendices we find a variety of matter of much interest and importance. We may briefly mention some of the results.

Kala-Azar.—It has been shown that cultures can be got from the blood, and the use of the method for diagnostic purposes is suggested; it should have been stated whether the case from which cultures were got showed parasites in the blood or not. Coccal bodies have been found in the organs in this disease but their meaning is not clear. Observations in the Sudan do not support the insect transmission theory of the disease. We have ourselves elsewhere suggested the hypothesis that the disease is not transmissible from man, but is acquired by infection with "natural" flagellates of some insect.

Entomology.—*Chrysops fixissima* of Borneo appears to be a terrible fly. Its bite on the ear gives rise to a swelling like a cauliflower.

A sand-fly larva has been found in soil in the Sudan. Hitherto they were thought to breed almost exclusively in old walls and the like.

A long and interesting paper is devoted to the life-history of *Dermatobia hominis*, the larva of which burrows in the skin of man, producing "warbles." The evidence is detailed in support of the view that certain mosquitoes, Janthinosoma, sp., are used by the œstrid for effecting this. Œstrid eggs have been found cemented to the abdomen of female mosquitoes, as the œstrid appears "to know" that the males do not bite man. When such a female with eggs in position bites, the œstrid larvæ hatch and find their way into the skin. We still require complete proof of this "fairy tale." We require to see an œstrid catch a mosquito and lay its eggs on the abdomen of the latter. We also require (with pocket lens) to see a mosquito with eggs attached biting, and then to see the larvæ emerge and enter the skin. The larvæ when grown and *in situ* are best chloroformed; they can then be fairly easily expressed.

Beri-beri.—A practical demonstration of the view now generally accepted that beri-beri is due to the absence of the subpericarpal layer in polished rice, was afforded by the result of an expedition to the Snow Mountains, in Dutch New Guinea. Previous expeditions had failed except one, of only ten men, and in this *unpolished* rice was used. The expedition here recorded consisted of 204 natives and lasted seven months. There was not a single case of beri-beri. The daily ration in grams was:—Rice, unpolished, 700; fish or meat on alternate days, 150; kachangidju (a bean), 200; Javanese sugar, 50; coffee, 20; tea, 5; salt, occasionally, 20. What is required of rice millers is to produce a "nice-looking" rice with the pericarp removed and the subpericarp retained. Rice millers must accept the facts and not deny that polished rice is a cause of beri-beri, as happened in the writer's experience recently. A rice containing not less than 0·4 per cent. of phosphorus pentoxide is a safe one, but inspection or other simple tests is quite enough to tell a safe from an unsafe rice. "Parboiled" rice is also safe, but many natives will not eat it, as it does not look nice and has an objectionable smell.

Leprosy.—The successful cultivation of the bacillus has been claimed by various observers, but in the experiments detailed in this report all attempts were negative, although the "successful methods of other observers were followed." The subject is at present in a state of hopeless confusion.

Bilharzia.—It has been shown by Japanese workers that the Japanese form of this disease was contracted (by dogs) by immersion in water. It was thought that this proved the direct penetration of the skin by the miracidia that hatched from the egg, but Leiper and Atkinson have shown that it is the Cercariæ which have passed through a mollusc that are the infective stage.

The appendices give evidence of the enthusiasm with which research is followed, but we think there might be some co-ordinating system linking together researches in various colonies.

RECENT ENTOMOLOGICAL RESEARCH.

NO English-speaking zoologist is likely to have overlooked the exhaustive work on the life-cycle of *Trypanosoma lewisi*, recently published in the *Quart. Journ. Microsc. Sci.* (vol. lx., part 4), by Prof. A. E. Minchin and Mr. J. D. Thomson. This great research involved the dissection of 1700 rat-fleas (*Ceratophyllus fasciatus*), and Prof. Minchin gives, in the last number of the Journal of the Quekett Microscopical Club (2, vol. xii., No. 76), as a kind of by-product, some details of the anatomy of the insect. The nervous system, reproductive organs, and salivary glands receive special attention. In the nervous system there is a curious sexual dimorphism, the male having eight distinct abdominal ganglia, while the female possesses only seven. The salivary glands of the larva are much larger than those of the adult, and the larval duct is provided with a reservoir, wanting in the corresponding imaginal structure; these differences are correlated with the well-known difference in the nature of the food, the flea being a blood-sucker, while the larva devours solid particles—commonly the excreta of the rat. Students of insect anatomy will be grateful to Prof. Minchin for his detailed account of his simple and successful methods of manipulation.

The woolly aphid of the apple, commonly known as "American blight," has been the subject of many interesting observations recently; for example, we have had Mr. J. Davidson's careful anatomical research into the different forms of the species (*Quart. Journ. Micr. Sci.*, vol. lviii., 1913, part 4), and Miss E. M. Patch's demonstration that the elm is the normal host-plant for the wingless sexual stage of the species and for the early spring generations (Maine Agric. Exp. Sta. Bull., 203, 217, 220, 1912–13). Now Mr. A. C. Baker has published (U.S. Dept. Agric., Report 101, 1915) a comprehensive account of the structure, life-history, and economic importance of the insect in a pamphlet of fifty-six pages, illustrated by fifteen excellent plates. He believes that the generic name Eriosoma (Leach, 1820) must supersede Schizoneura (Hartig, 1841), which has been universally used in recent years. As regards the life-cycle, he confirms the latest conclusions of Miss Patch that *E. ulmi* is identical with the currant-root feeding *fodiens*, while *E. lanigera* (the "American blight") is an altogether different species, with the elm as its normal "principal" host, and the apple, hawthorn, and rowan as alternative summer hosts. As a matter of fact, the virgin females of *lanigera* are commonly found on the bark or roots of apple-trees throughout the winter months, so that the sexual phase may be tending to disappear from the life-history altogether. It is interesting—after so many American writers have objected to the identification of their continent as the original home of this "blight," and have contended for its European origin—to find it here considered that the weight of evidence indicates the insect as a native of the "New World."

A similar doubt as to the country of its origin exists with regard to another orchard insect-pest, the pear thrips (Euthrips, or *Taeniothrips pyri*), which since 1900 has caused much damage both in the eastern and western United States, and in some English localities. A complete account of its life-history and habits in California, by Messrs. S. W. Foster and P. R. Jones, has just been published (U.S. Dept. Agric. Bull. 173). The adults feed in the blossom-buds, and the larvæ on the fruits, not of the pear only, but of other rosaceous trees; while pupation takes place in the soil, the transformation being completed about midwinter, though the winged thrips do not appear until some months later. In California all the adult individuals are believed to be parthenogenetic females, although males have been found in this country by Mr. R. S. Bagnall.

Dr. A. D. Hopkins continues his excellent systematic studies of the bark-beetles, with a "Classification of the Cryphalinæ" (U.S. Dept. Agric., Report 99), in which some new genera and a large number of new species are described, the latter not being all North American. This is the fourth "Contribution towards a Monograph of the Scolytoid Beetles," the second having appeared in the Proc. U.S. Nat. Mus., vol. xlviii., and the first and third as No. 17 of the Technical Bulletins of the U.S.D.A. Bureau of Entomology. This disconnected mode of publication—somewhat troublesome to the bibliographer—is due to the discontinuance of the special series of bulletins hitherto issued by the Bureau of Entomology, the results of the work of which will apparently henceforth be mingled with those emanating from other sections of the Department of Agriculture. From this centralisation there may perhaps be some benefit derivable that is not apparent to an ordinary entomologist, who cannot fail to appreciate its inconvenience. Report 107 of the U.S. Department of Agriculture consists of a short but valuable and beautifully illustrated paper on the larvæ of long-horn beetles of the division

Prioninæ, by F. C. Craighead. In the *Journ. Agric. Research* (vol. iv., No. 3) W. S. Pierce describes weevils of the genus Diaprepes, which injure sugar-cane in the West Indies, and gives details as to their variation and life-history.

The gipsy moth (*Porthetria dispar*) imported from France into Massachusetts in 1869 continues to occupy the attention of American entomologists; Mr. A. F. Burgess describes the means adopted in the New England States for checking its ravages (Bull. U.S. Dept. Agric., 204). His account is illustrated by an interesting set of maps showing the present range of the species in New England, and also of some of its natural enemies which have been imported from Europe, of which the large ground-beetle, *Calosoma sycophanta*, is the most formidable. Reference is also made to the strange "wilt-disease" which at times fortunately becomes epidemic among the caterpillars. It has been made the subject of a special research by Mr. R. W. Glaser (*Journ. Agric. Research*, vol. iv., No. 2). He finds that the disease was not present in North America before 1900, and believes that its spread may be at least partly due to some of the introduced parasites. The causative micro-organism has not been demonstrated.

The cabbage-fly (*Phorbia* or *Chortophila brassicae*) is one of our commonest and most destructive garden pests. Mr. J. T. Wadsworth has published (*Journ. Econ. Biol.*, vol. x., No. 1) a valuable and interesting account of a rove-beetle, *Aleochara bilineata*, the larva of which eats its way into the puparium of the cabbage-fly, and feeds on the pupa. Like some other beetle life-histories, this shows a tendency to hyper-metamorphosis, the newly-hatched Aleochara being of the campodeiform type normal to the family, while the later instars, in accordance with their parasitic habit, have shortened legs and swollen bodies, approaching the cruciform type.

A contribution to our knowledge of the physiology of aquatic insects is due to Mr. S. K. Sen, who gives some observations on the respiration of Culicidæ (*Indian Journ. Med. Research*, vol. ii., No. 3). The larva of *Culex microannulatus* consumes 1·1 cubic mm. of oxygen per hour, the pupa 1·9 cubic mm., and the imago 2·5 c.c.; the increased oxygen-hunger of the pupa as compared with the larva is noteworthy, and it was found that the pupa is more quickly affected and killed by the want of oxygen. Systematic study of blood-sucking Diptera goes steadily on; the British species of Simulium are diagnosed by Mr. F. W. Edwards in the last number of the *Bulletin of Entom. Research* (vol. vi., part 1). This same number contains a report by Dr. W. A. Lamborn on the "control" of tsetse-flies (Glossina) in Nyasaland; a number of flies were caught by bird-lime spread on boards carried about by native boys, and digging-wasps are found to seize tsetses and carry them off. Hymenopterous parasites of the Chalcidoid group have been reared from Glossina puparia in northern Rhodesia, and these are described with excellent figures by Rev. Jas. Waterston, in the same number of the bulletin.

Of slight importance from the economic point of view, the Odonata (dragonflies) are yet of great general interest to the student of insects. Mr. E. B. Williamson has just published (Proc. U.S. Nat. Mus., vol. xlviii., pp. 601–38) some exceptionally valuable notes on Neo-tropical species belonging to the "demoiselle" (Agrionine) subfamily. The purely systematic entomological paper is usually a weariness to any not a specialist who may attempt to read it, but this author enlivens his accounts of structural details of diagnostic value with descriptions of the habits and adaptations of the beautiful insects which he loves to observe when alive in the swamps and forests of Central America and the Antilles.

G. H. C.

THE NATURAL HISTORY OF CORUNDUM.[1]

In the Summary report of the Geological Survey of Canada for 1896 Mr. W. F. Ferrier directed attention to the occurrence of corundum crystals in the township of Carlow, Hastings County, Ontario, and to the probable economic importance of the discovery. This announcement led to the opening up of what has become the largest corundum mining industry in the world. In 1910 an important memoir by Adams and Barlow on the general geology of the district in which the corundum-deposits occur was published by the Geological Survey (Geology of the Haliburton and Bancroft Areas, Memoir No. 6), but the details as to these deposits were reserved for fuller treatment than was possible at that time. They are now given in the present volume, together with a general account of the occurrences of the mineral in other parts of the world.

Apart altogether from their economic importance, the Canadian deposits are of considerable scientific interest as throwing light on one of the methods by which corundum has been naturally produced. They are usually associated with nepheline and other alkaline syenites which occur at the junction of the great Laurentian granitic batholiths with the limestones of the Grenville series. Red alkaline syenites, rich in soda, together with their coarse-grained pegmatitic equivalents, are pre-eminently the corundum-bearing rocks throughout the district, although in one of the smaller areas the mineral occurs in anorthosites. The richest rock is known as corundum-pegmatite, dykes of which may attain a width of 18 ft. and contain as much as 75 per cent. of corundum. Individual crystals weighing 30 lbs. have been obtained from this rock. In other rocks they are smaller in size, and often sink to microscopic dimensions. The colour usually varies from blue to white. No transparent varieties suitable for use as gems have as yet been found.

In his classic researches carried out in Warsaw during the years 1891–96 and published in *Tschermak's Mineralogische und petrographische Mittheilungen* for 1898, Morozewicz proved that felspathic magmas, especially those rich in soda, possessed the power of dissolving alumina, and that on cooling the excess of alumina over that required to form felspar crystallised out as corundum. The facts described in this memoir clearly prove that the Canadian corundum has crystallised out of a highly felspathic magma in accordance with the principles experimentally established by Morozewicz. The mineral is extracted from the rocks by blasting, hand-picking, crushing, and dressing by methods akin to those frequently used by miners. From material fed to the mills containing 10½ per cent. of corundum a high-grade product consisting of from 90 to 95 per cent. is obtained. It is at present employed solely as an abrasive agent, although researches have been, and are still being, carried out to discover other uses. The value of the total amount placed on the market to the end of 1913 is about 2,000,000 dollars, and there has been no appreciable falling off in the amount produced during recent years. Its principal rivals are carborundum and artificial corundum, known as alundum, both of which are produced at Niagara Falls.

ANCIENT ARABIC METEOROLOGY.[2]

At what stage of intellectual development, premonitory signs of weather were first connected with coincident, but probably unrelated, phenomena,

[1] "Corundum: Its Occurrence, Distribution, Exploitation and Uses." By Alfred Ernest Barlow, Department of Mines, Canada. Pp. 377+28 plates and a geological map of Central Ontario.

[2] "Some Arabic Weather Sayings." By Mohammad Bey Kasim. Reprinted from the *Cairo Scientific Journal*, Nos. 97 and 98. (Alexandria, 1914.)

and expressed in popular phrases is doubtful, but in every part of the world may be found a stock of proverbs that express the general experience. Egypt, of course, is no exception to the rule, and, owing to its old civilisation, it is probable that in these wise saws we have the fruits of the earliest meteorological observations. We cordially welcome, therefore, the paper by Mohammad Bey Kasim, who by industriously collecting a long list of these predictions, and translating them into English, has benefited both meteorology and folklore.

In a climate where the changes are frequent and apparently lawless, these are apt to be assigned to frivolous and irrational causes, but in more settled climates, as that of the Nile Valley, the prognostications may be regarded as founded on a more scientific basis. Weather changes are seasonal, rather than daily, and as the Coptic year is based on solar reckoning, the repetition of the same phenomena at nearly the same dates in successive years would tend to confirm the accuracy of the proverb, and give rise to a running commentary on the calendar, useful in the guidance of husbandry and agricultural operations.

Thus in the month Abib (July 8–August 6) we have in its translated form the saying:

> In Abib, it will be found
> We hear the running water's sound.

referring to the expected rise of the Nile, and, in the following month, Misra:

> Misra makes all the watercourses flow,
> Though difficulties it must undergo.

That the proverb-mongers were quite aware of the necessity of making provision for the variability of seasons, and not limiting the changes too rigidly to the arbitrary divisions of months, is shown by an ingenious interlocking of Amshir and Baramhat, which together include the spring from February 8–April 8, when periods of warm and cool weather will interchange:

> The month of Amshir to Baramhat says:
> Exchange ten of mine for ten of your days.

The author does, however, give a complete calendar, in which apparently an attempt is made to foretell the weather from day to day, but it is not clear whether this is a perpetual calendar, or liable to revision from year to year according to the fancy of the local expert. For comparison additional information founded on average meteorological data is supplied. The main climatological factors are sufficiently well indicated. Thus for 22 Tut (October 2) the comment is, "No hope of more rises of the Nile." The Cairo observations show that that date is the mean, and not the extreme of maximum flood, for which the variation is ±16 days. The fixing of the low stage of the Nile to 27–28 Bashans (May 4–5) is not so happy. The mean date from 1873 has been about a month later, but since the Aswan Reservoir has been utilised a comparison of dates may be misleading. The fact that is emphasised by this calendar is the advantage due to employing the apparent motions of the sun, as shown by the assistance given to the old meteorologists in the maintenance of a continuous record.

Another feature of this admirable compilation is the successful attempt to classify the terms used in Egypt to describe the degrees of variation in the climatological elements. The Egyptian vocabulary seems to be wide and rich; seven terms are given expressing gradations of "cold," and a round dozen for different degrees of heat. Naturally there must be a good deal of overlapping, and the phrase, "the hot weather (el harr) lasts seven days or three," may be capable of very wide interpretation. Apparently the author has been very successful in accommodating the terms expressing varying strength of winds to our Beaufort scale, and the accuracy in the two cases is no doubt comparable, since each depends on eye observation and memory. The forms of clouds, too, have long been described with sufficient accuracy, and Luke Howard, who has supplied our nomenclature, has but followed an unknown, but ancient, classification. We are glad to know that Mohammad Bey proposes to continue his investigations into a subject that cannot but grow more interesting the further it is pursued.

COMPETITIONS IN CONNECTION WITH THE UTILISATION AND DENATURING OF SPIRIT OR ALCOHOL FOR INDUSTRIAL PURPOSES.

THE following particulars have been received by the Board of Trade, through the Foreign Office, from the Russian Ambassador in London, respecting the international competitions organised by the Russian Ministry of Finance in respect (1) of methods of utilising spirit or alcohol or their products, and (2) of new substances for denaturing spirit or alcohol for industrial purposes.

As regards the first-mentioned competition, prizes of 60,000, 30,000, and 10,000 roubles, respectively, will be awarded for the invention of a novel means of adapting alcohol for the preparation of such a product as shall by its nature absolutely differ from the spirit from which it is made, *e.g.* vinegar, ether, chloroform, etc. Three prizes, of 50,000, 20,000, and 5000 roubles, respectively, will be awarded for the invention of a novel method of utilising spirit for the preparation of a product (*e.g.* a pharmaceutical or perfumery preparation) of which spirit or its products (sulphuric ether, etc.) will appear as one of its component parts or dissolvent, providing that spirit cannot be extracted profitably from the product. Three prizes of 30,000, 15,000, and 5000 roubles, respectively, will be awarded for the invention of a novel method of utilising spirit in productions, where spirit or its products would serve as temporary intermediary dissolvents of either of the extracted or precipitated materials, *e.g.* in the manufacture of smokeless powder, artificial silk, etc. Further prizes ranging from 75,000 to 5000 roubles will be awarded for the invention or perfection of apparatus for the utilisation of spirit as motive power, fuel, or illuminant.

The competition of new substances for denaturing spirit or alcohol is being organised with the object of extending the use of spirit for technical purposes, and accordingly three prizes of 30,000, 15,000, and 5000 roubles, respectively, are offered for finding novel denaturing materials for improving the existing methods of denaturing, which, whilst guaranteeing the free use of denatured spirit, would obviate any possibility of using it as a beverage.

Applications in respect of both these competitions should be addressed to "L'Administration générale des Impôts indirects et du Monopole de l'Alcool," Tutchkoff Naberezhnaia, Petrograd, not later than January 11–14, 1916, and must be accompanied by samples. Such applications should be made in the Russian or French languages, and be enclosed in a special envelope bearing an inscription or device of some sort, the name and address of the applicant being submitted under separate cover bearing the same inscription or mark.

Inventors may reserve the right of benefiting by their inventions and of protecting themselves with letters patent.

Copies of the full text of the conditions for participating in the two competitions above referred to may be obtained by United Kingdom firms interested, on application to the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

GRANTS FOR SCIENTIFIC INVESTIGATION AND UNIVERSITY WORK.

WHEN the Government scheme for the promotion of scientific and industrial research was announced in the House of Commons in May last, it was stated that, to begin with, a sum of 25,000*l.* would be placed at the disposal of the advisory council appointed in connection with the scheme. This sum, and any other amounts voted by Parliament for the same purpose, will be included in the Civil Service Estimates under the Grants in Aid of Scientific Investigation. All the grants made under this head for 1915–16, together with grants from the Development Fund, and to universities and university colleges, are shown in the subjoined statement from the ninth annual report of the British Science Guild. The provision which is now being made for research gives topical interest to the facts here brought together.

GRANTS FOR SCIENTIFIC INVESTIGATION.

The annual grants made by Parliament specifically for scientific investigations and related services amount to about 100,000*l.*, and the details of the estimates for 1915–16 are shown in the subjoined table.

	£
Royal Society:—	
(i) (*a*) Scientific Investigations ...	4,000
(*b*) Scientific Publications	1,000
(ii) Magnetic Observatory at Eskdalemuir	1,000
(iii) National Physical Laboratory ...	7,000
(iv) Aeronautical Section of the National Physical Laboratory	9,425
Meteorological Office	22,500
Royal Geographical Society	1,250
Royal Academy of Music	500
Royal College of Music	500
Marine Biological Association of the United Kingdom	500
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	1,600
Royal Irish Academy of Music	300
Royal Zoological Society of Ireland ...	500
Royal Hibernian Academy	300
British School at Athens	500
British School at Rome	500
Royal Scottish Geographical Society ...	200
National Library of Wales	8,200
National Museum of Wales	17,300
Solar Physics Observatory	3,000
British Academy	400
School of Oriental Studies	1,500
North Sea Fisheries Investigation ...	1,250
Imperial Transantarctic Expedition, 1914–15	5,000
Edinburgh Observatory	1,657
	£90,582

The grants to the National Physical Laboratory and the Meteorological Office, amounting altogether to nearly 40,000*l.*, are for direct national services rather than scientific investigation; and when these amounts are deducted the actual sums voted by the State to scientific institutions, or for purposes of research, show little relationship to those which the trustees of the Carnegie Institution of Washington are able to give. The institution was founded by Mr. Carnegie in 1902, with an endowment of 2,000,000*l.*, to which he added 400,000*l.* in 1907, and a further 2,000,000*l.* in 1911. The articles of incorporation of the institution declare "that the objects of the corporation shall be to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind." The grants made by the trustees amount to nearly a quarter of a million pounds annually.

In addition, however, to the specific State grants under the foregoing head of scientific investigation, much larger funds are at the disposal of the National Health Insurance Joint Committee and the Development Commissioners.

Under the National Health Insurance Act the annual revenue accruing from one penny in respect of each insured person (payable out of moneys provided by Parliament) provide a fund from which grants are available for the purposes of medical research. The total amount available annually for this purpose is about 56,000*l.*

GRANTS FROM THE DEVELOPMENT FUND.

The Report of the Development Commissioners for the year ended March 31, 1914, describes the work of the Commission during the year 1913–14. Attention is directed to three cardinal facts relating to the provisions of the Acts constituting the Development Fund and Commission. First, the amount hitherto appropriated by Parliament to the Fund is 2,900,000*l.*; secondly, the Commissioners are a purely deliberative and advisory body, having no power themselves to carry out schemes of which they approve; thirdly, grants and loans from the Fund can only be made for certain specified purposes (speaking generally for the development of the agriculture and fisheries of the United Kingdom and for connected purposes such as forestry and the construction and improvement of canals and harbours) and to certain specified bodies, which do not include companies trading for a profit.

The expenditure actually recommended by the Commissioners, under the head of Agricultural and Rural Industries, during the year 1913–14 was 472,793*l.* (practically all grants), as compared with 227,600*l.* during 1912–13. This large increase is due partly to the fact that during 1913–14 three or four large grants were recommended for capital expenditure on buildings, and for some years' working of a scheme which could not be started on the basis of annual grants; such advances as 28,650*l.* for a veterinary laboratory for the Board of Agriculture and Fisheries, 18,000*l.* for buildings for the Edinburgh and East of Scotland College of Agriculture, 28,675*l.* for a ten years' scheme of tobacco experiments in Ireland, 10,325*l.* for buildings at Reading University College, 10,000*l.* for buildings at the Midland Agricultural and Dairy College, are not annual requirements. The grant to the Board of Agriculture and Fisheries in aid of agricultural research and experiments during 1914–15 was 46,900*l.*, and for the Farm Institutes scheme 58,350*l.* Under the head of forestry the advances recommended by the Commissioners amounted to 91,100*l.*, and the grants actually made amounted to 34,500*l.*, of which 650*l.* was for forestry research and advisory work during 1913–4 and 810*l.* for the same purposes in 1914–15. The total grants made in connection with fisheries were 20,900*l.*, of which 11,100*l.* was for fishery research and 2000*l.* a supplementary grant for a fishery research vessel.

The Report concludes with the following statement of the position of the Development Fund and Commission:—

The total amount guaranteed to the Fund for the period up to the end of the financial year 1914–15 was 2,900,000*l.*, the whole of which sum has been paid over to the Fund.

Up to March 31, 1914, the Commissioners had actually recommended advances up to the amount of 1,493,375*l.*, of which 1,216,695*l.* were grants and 276,680*l.* loans. The main reason for the excess of grants over loans is the large expenditure on education and research—purposes which for obvious reasons are scarcely suitable subjects for loans. Of this sum, perhaps 220,000*l.* may be deemed to have lapsed, owing to such causes as the failure of applicants to expend the whole advance sanctioned during the period for which it was advanced. It would appear that if the amount of the Development Fund is 2,900,000*l.*, and effective advances to the amount only of 1,280,000*l.* were sanctioned up to March 31, 1914, the sum of 1,620,000*l.* still remains unappropriated. This is, however, not the case; the Commissioners having been compelled to commit themselves in substance to expenditure much in excess of the advances actually recommended.

The expenditure incurred or sanctioned for the period up to March 31, 1916, in connection with agriculture and rural industries, forestry and afforestation, and fisheries is as follows:—

(1) *Agriculture and Rural Industries.*—This purpose has absorbed a considerably larger proportion of the Fund than any other object. The expenditure hitherto sanctioned is 921,549*l.*, of which perhaps 200,000*l.* has lapsed. During 1914–15 and 1915–16 some 400,000*l.* more may be required, mainly for the following objects —the continuance of the schemes of research, technical advice, and instruction in agriculture already set on foot throughout the United Kingdom; buildings and farms for agricultural colleges; further provision for research in veterinary science; the continuance of the existing schemes for the improvement of cattle, light horse and other live stock breeding, and the promotion of co-operation. It would certainly not be safe to place the total demands for these purposes at less than 1,100,000*l.*

(2) *Forestry and Afforestation.*—The total amount recommended hitherto for this purpose is 142,749*l.*, of which rather more than 80,000*l.* has been advanced by way of loan. But large demands must be anticipated during the next two years, as several schemes which have taken some time to mature are now, it is hoped, approaching completion. These include a Scotch demonstration area, the acquisition of one or more experimental areas in England and Wales, afforestation schemes for land already purchased in Ireland, and loans to local authorities for the afforestation of water catchment areas. The Commissioners reserve, conjecturally, another 200,000*l.* for these purposes up to 1916—making the total expenditure 350,000*l.*

(3) *Fisheries.*—65,557*l.* has been advanced for this purpose; but a large scheme of research is now being considered. 150,000*l.* is provisionally taken as the total expenditure, but this estimate is even more conjectural than the others given.

The total sums for all purposes is 2,250,000*l.*

The net result is that the Commissioners estimate that on March 31, 1916, the amount actually spent from the Development Fund will not be less than 2,000,000*l.*; it may be 200,000*l.* or 300,000*l.* more. After that date an annual sum of approximately 275,000*l.* will be required to keep in operation schemes already sanctioned for such purposes as agricultural research, forestry, and fisheries research, and agricultural education, which ought to be continued permanently or at least for some years.

GRANTS FOR UNIVERSITY EDUCATION.

The universities and university colleges in Great Britain which are in receipt of grants from the Board of Education are as follows:—The Universities of Birmingham, Bristol, Durham (Armstrong College), Leeds, Liverpool, Manchester, Sheffield, London (including University College, King's College, Bedford College, School of Economics, and East London College), the University Colleges of Nottingham, Reading, and Southampton; the University of Wales (University Colleges of Aberystwyth, Bangor, and Cardiff).

The subjoined table shows the sources of income of these institutions:—

Incomes of Universities and University Colleges.

	(1) ENGLAND. Amount. £	Per cent. of total	(2) WALES. Amount. £	Per cent. of total
Fees	183,880	27·8	17,456	27·7
Endowments	95,045	14·4	4,448	7·1
Donations and subscriptions	22,381	3·4	2,330	3·7
Annual grants from local authorities	103,650	15·7	3,441	5·5
Parliamentary grants (see below)	233,000	35·2	34,220	54·3
Contributions from hospitals, etc., for services rendered	2,338	0·4		
Other income	20,486	3·1	1,132	1·7
	660,780		63,027	

Grand Total, £723,807.

The income from endowments of universities and university colleges in England and Wales in receipt of State grants is about 100,000*l.*, which is also the amount of the annual income of the Carnegie Trust for the universities of Scotland. About half this amount is devoted annually to the payment of students' fees, and the other moiety is voted as grants for (1) the better equipment of the Scottish universities and colleges by the foundation of additional chairs and lectureships and by the provision of new laboratories and permanent equipment, and (2) the encouragement of research. A writer in NATURE of May 14, 1914, in an article upon the twelfth annual report of the trust, says:—"The impetus to research which has been produced by the work of the trust can be gauged from an example chosen from one science, chemistry. In the eight years 1903–11, the trust appointed in this department forty-five scholars, twenty-five fellows, and thirty-one grantees. The work of these has resulted in the publication of more than 130 original communications to scientific journals. Now, in 1912, the contributions of the whole British chemical world to the Transactions of the Chemical Society amounted to only double this number, 266, so that it is evident that the Carnegie Trust, by its encouragement of research, has indirectly in the course of eight years produced a series of results equal to half the annual output of the whole Empire at the present time. This, it must be remembered, represents only a single department of the trust's activities; for, in addition to chemistry, work is being carried out in physics, biology, medicine, economics, history, and languages."

The Parliamentary grants to universities and university colleges (1912–13) included in the foregoing table are made up of contributions under various heads as shown below:—

	ENGLAND	WALES
Exchequer	170,000	25,500
Board of Education: Technological and other Professional Work	22,600	430
Board of Education: Training of Teachers ...	22,400	4,990
Board of Education: Other Grants	8,500	230
Other Government Departments	9,500	3,070
Total	£233,000	34,220

The grants for technological and other professional work, amounting to about 23,000*l.*, are part of a total sum of nearly 45,000*l.* allocated under this head in 1913–14. Twenty-four institutions in all receive State aid in this way, ten of them being also in receipt of the Exchequer grants to universities and colleges.

In Germany, State subsidies provide the main part of the incomes of the universities. The annual expenditure for the universities from State funds amounts in round figures to 1,800,000*l.* In 1913 the expenditure of the University of Berlin alone was 242,000*l.*, and of this amount 200,000*l.*, or about 83 per cent., was derived from State funds.

The estimates for the year ending March 31, 1916, show the following grants for universities and colleges in the United Kingdom:—

Great Britain.	£	
University of London	8,000	
Victoria University of Manchester	2,000	
University of Birmingham ...	2,000	
University of Wales	4,000	
University of Liverpool	2,000	
Leeds University	2,000	
Sheffield University	2,000	
Bristol University	2,000	
Durham University	2,000	
Scottish Universities	84,000	
Colleges, Great Britain	150,000	
University Colleges, Wales ...	12,000	
Welsh University and Colleges: Additional Grant	15,000	
Total		£287,000

Ireland.		
A.—Grants for the General Purposes of the	£	
Queen's University of Belfast	18,000	
University College, Dublin ...	32,000	
University College, Cork ...	20,000	
University College, Galway ...	12,000	
B.—Grants in respect of the Cost of Purchasing Lands and Providing or Improving the Necessary Buildings and Equipment for the—		
National University of Ireland and University College, Dublin	40,000	
University College, Galway (185*l.* revote)	—	
C.—Additional Grant in augmentation of sums amounting to 1500*l.* or more contributed from local sources in 1914–15 towards increasing the Resources of University College, Galway ...	2,000	
Total		£124,000
Imperial College of Science and Technology	30,000	
Royal College of Science, Dublin ...	17,000	
University Institutions in respect of Technological Work	59,000	
Grand total		£517,000

Certain of the universities, colleges, and other similar institutions which are in receipt of Parliamentary grants have been adversely affected by the war, more especially by the loss of fee income arising from the widespread response among men students to the call for recruits. The estimates for 1915–16 include, therefore, a special grant of 145,000*l.* in aid of such universities, colleges, medical schools, and agricultural institutions, to meet loss of income arising during the war.

Benefactions.

The benefactions to higher education in the United States during the forty years from 1873 to 1913 amounted to nearly 100,000,000*l.*, and are still increasing at the rate of about 5,000,000*l.* annually.

The report of the United States Bureau of Education for the year ending June 30, 1913, shows that during the year the total sum received in gifts and bequests by universities and other institutions of higher education, excluding grants by the United States, different States, and municipalities, was 4,930,390*l.* Of this amount 895,320*l.* was for increase of plant, 825,980*l.* for current expenses, and 3,209,100*l.* for endowment. Forty-five institutions reported gifts of more than 20,000*l.*

The income of the 596 institutions of higher education from which the Bureau receives reports was during the year, from State and municipal grants, 3,809,960*l.*; from invested funds, 3,313,960*l.*; and from fees for tuition and other educational services, 4,183,830*l.*

Summary.

The Carnegie Institution of Washington has an endowment fund of 4,400,000*l.*, and makes grants of nearly 200,000*l.* annually for purely scientific investigations and publications.

The Parliamentary grants in aid of scientific investigation, including the services of the Meteorological Office and the National Physical Laboratory, amount to about 100,000*l.* annually, or 125,000*l.* including the new grant recently made.

The grants for the purposes of medical research, under the National Health Insurance Act, amount to about 56,000*l.* annually.

The total amount appropriated by Parliament to the Development Fund is 2,900,000*l.*; and it is estimated that up to the end of March, 1916, the expenditure will be on agriculture and rural industries 1,100,000*l.*, on forestry and afforestation 350,000*l.*, and on fisheries 150,000*l.*

The Parliamentary grants for universities and colleges in the United Kingdom amount to about half a million annually; the State grants to universities in Germany reach nearly two millions annually.

The benefactions to institutions of higher education in the United States amount to about five millions annually; in the United Kingdom the average is less than one-tenth this sum.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—The following science appointments have been made by the council of Bedford College for Women:—Assistant-lecturer in philosophy, W. A. Pickard-Cambridge; assistant-lecturer in physics, Miss M. O. Saltmarsh; demonstrator in physics, Miss M. Baxter; demonstrators in physiology, Miss Hartwell and Miss Tweedy; demonstrator in geology, Miss I. Lowe.

Oxford.—Captain C. F. Balleine, fellow and sub-rector of Exeter College, who was killed in action on July 2 (a note on whom appeared on p. 543 of our issue for July 15), bequeathed 1000*l.* to the rector and scholars of Exeter College, to be employed in some way for the benefit of that college as the governing body may direct.

The foundation stone of the new Welsh National School of Medicine at Cardiff was laid on Thursday last by Lord Pontypridd.

A laboratory for the investigation of occupational diseases is to be established in Pittsburgh, under the supervision of Dr. J. W. Schereschewsky, of Washington.

A proposal is on foot to endow the library of the department of mathematics of Brown University in honour of Prof. N. F. Davis, who, after upwards of forty years' service, is shortly to retire.

The sum of 8500 dollars has been given by Miss E. Cuyler and Mr. T. De Witt Cuyler to the George

Peabody College for Teachers for the equipment of the Jesup psychology laboratory of the institution.

THE sum of 1,145 dollars has been given to the University of California for the carrying out of the survey of the animal and bird life of the Yosemite National Park, by the California Museum of Vertebrate Zoology.

DR. F. BILLINGS, of Chicago, is announced to deliver the next course of Lane medical lectures at the School of Medicine of Stanford University. He will take as his subject, "Focal Infection," and the course will extend from September 20 to 25 next.

WE notice the following appointments in connection with American colleges:—Prof. H. S. Jackson, of the Oregon Agricultural College, to be head of the botany department of the Purdue University Agricultural Experiment Station, in succession to Dr. J. C. Arthur; Dr. E. W. Sinnott, of the Bussey Institution, to the chair of botany and genetics at the Connecticut Agricultural College.

TROOP COLLEGE OF TECHNOLOGY, Pasadena, has recently received from an anonymous donor the sum of 10,000 dollars towards the equipment of a research laboratory in physical chemistry, and the promise of a like amount yearly for the maintenance of the laboratory. Dr. A. A. Noyes is to be in charge of the new department, dividing his time between Troop College and the Massachusetts Institute of Technology.

ACCORDING to the Bulletin of the John Rylands Library, Manchester, the appeal on behalf of the University of Louvain which was made by the bulletin has met with a very encouraging reception, upwards of 3000 volumes having already been received or promised. We are glad to learn that an international committee is in process of formation, with the view to co-ordinate the many efforts that are being employed in this country, and also on the Continent, to assist in bringing about the restoration of the devastated library.

THE calendar for the year 1915 of the National University of Ireland is now available. Among the changes in the courses and in the regulations for the year 1916 of which notice is given may be mentioned those in connection with the matriculation examination, travelling studentships, and the courses for higher degrees. For the purposes of matriculation the University is prepared to accept the certificates of a number of examining boards in the British Isles and Australia, and the matriculation certificates of ten specified universities. In addition, any person who has matriculated in any university of the British Dominions and Colonies, other than those already referred to, and has also passed an Intermediate examination in arts or science in that university, will be exempted from the matriculation examination of the National University of London.

SIR A. H. CHURCH, who died on May 31, left to the Royal Society his reversionary interest in forty-three 20*l.* shares in the London County and Westminster Bank (Limited) with the request that when it falls into possession the income may be applied for purposes connected with the preservation or utilisation of the archives of the Royal Society; 500*l.* to the rector and fellows of Lincoln College, Oxford; to the Waynflete professor of mineralogy in the University of Oxford 100*l.* for the purchase of apparatus and mineral specimens, together with the testator's microscope and other optical instruments and mineral specimens, and his chemical apparatus; and 100*l.* to the curators of the Ashmolean Museum. He further requested his wife to make, among others, the following gifts in her lifetime or bequests at her death:—To the trustees of the British Museum for the mineralogical gallery in the Natural History Museum, his collection of cut precious stones, or such thereof as the keeper of the minerals may select; to the curators of the Ashmolean Museum, Oxford, his collection of Japanese sword guards, and of sliders or beads, and of Chinese and Japanese bronzes, several Indian glass sprinklers, and a number of other curios and antiques.

THE Berne correspondent of the *Morning Post*, quoting from the *Akademische Rundschau*, gives some interesting information respecting the effects of the war upon the German universities, technical schools, and colleges. It is stated that in the summer term of 1914 there were, at the twenty-two German universities, eleven technical academies, five commercial schools, three veterinary schools, and six agricultural and mining schools, 79,077 students entered, a number which in the autumn of 1914 had sunk to 64,710. Of this number the following were under arms:—

University students	36,000
Technical students	8,000
Commercial students	6,000
Veterinary students	300
Agricultural students	300
Mining students	300
Total	50,900

The following are the *percentages* of students of some of the universities who have gone to the front:—Königsberg, 84; Heidelberg, 60; Munich, 56; Berlin, 54; Frankfurt, 11. Of the technical academies Danzig sent the highest proportion of students—90 per cent. The total number of German professors and students killed in the war, up to the end of May, is said to be 1191; Leipzig University has suffered most severely, losing 266 of its students.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 2.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The letters of L. Euler in the correspondence of J. N. Deslisle. H. **Douvillé**: The Orbitoids of Trinity Island. The distribution of these foraminifera is utilised for the classification of the Eocene strata at Trinity Island.—W. **Kilian** and Antonin **Lanquine**: The tectonic complications of the south-eastern portion of the Basses-Alpes, near Castellane.—A. **Leduc**: The internal pressure of gases. The influence of temperature. Experimental data for sulphur dioxide at temperatures between 0° and 1000° C. are not in good accord with the formulæ of Clausius and Sarrau. A new expression is proposed which presents the experimental results with greater exactness.—Sabra **Stefanescu**: The origin of some accidents of the crown of elephants' molars.—Louis **Gentil**: The analogies of the Moroccan Haut Atlas and Atlas of the Sahara.—R. **Chudeau**: Temperature in western and equatorial Africa.—V. **Wallich**: The suppression of suppuration in war wounds. The treatment, the very favourable results of which are described, is based on suppressing all causes of irritation at the level of the wound, together with the use of a stringently aseptic dressing. No antiseptics are used, draining tubes are removed as early as possible, and the compresses are moistened with a solution of common salt (one tablespoonful to the litre of water) sterilised by boiling for fifteen minutes before use.—V. **Galippe**: Parasitism in seeds and its importance in general biology. Experiments carried out on thirty-one species of plants showed that normal seeds can contain parasites. In ninety series of experiments seventy-eight results were positive. The parasite was usually a fungus, more rarely a yeast. The possibility of these parasites causing sudden mutations in plants is discussed.—

Edmond **Perrier**: Remarks on the preceding paper.—Armand **Gautier**: Remarks on the same note of V. Galippe.

August 9.—M. Ed. Perrier in the chair.—J. Comas **Solà**: Stereoscopic photography in the study of the proper motions of stars. The method is based on the extreme delicacy of the eyes, which are capable of producing sensations of relief by displacements of the order of 1μ to 2μ, even making use of an ordinary stereoscope. Placing in a stereoscope two corresponding images of regions near star cluster M. 11, one taken July 12, 1912, and the other July 20, 1915, numerous stars show in relief. In a surface of 20° square, no fewer than 200 stars give evidence of movement after three years.—Thadée **Banachiewicz**: The method of Olbers and multiple solutions.—Arnaud **Denjoy**: The four fundamental cases of derived numbers.—J. **Vallot**: Correction for the error introduced by the containing vessel in the determination of the diathermic power of liquids. The usual method of correcting for the effects of the containing walls is erroneous, owing to reflections due to the different refractive indices of glass and liquid. A slight modification of the usual measurements eliminates this error. Albert **Gascard** and Emile **Beignot-Devalmont**: The localisation of projectiles by radiography.—F. **Bodroux**: A method of preparation of hydrocarbons of the formula $(C_6H_5)_2CH.R$, R being an aromatic nucleus. Phenylmagnesium bromide and bromodiphenylmethane react readily in ether solutions giving triphenylmethane. Paratolyldiphenylmethane and α-naphthyldiphenylmethane can be prepared with good yields by a similar reaction.—E. **Léger**: The resolution of β-nataloin and β-homonataloin into their optical isomerides.—I. **Pouget**: The use of aluminium in preventing deposits in boilers. It is well known that laboratory water baths provided with arrangements for keeping a constant level, when fed with hard waters are put out of action through the feed tube becoming choked with scale. The author has used a water-bath, painted inside with aluminium paint, for three years, nearly continuously, without stoppage, and gives the results of experiments showing that the presence of aluminium greatly diminishes scale formation.—MM. **Russo** and **Tussau**: Geological expeditions through central Morocco.—Emile **Belot**: The deficit and excess of the acceleration of gravity on continents and islands with respect to the isostatic condition of the earth's crust.—Henry **Hubert**: The climates of western Africa.—F. **Garrigou**: Waters containing chlorides and iodides, bromides, sulphides and metals at Beaucens (Hautes-Pyrénées).—Mme. A. **Laborde**: The action of radium on vicious scars resulting from war wounds. The radium radiation was used after filtration through 0·5 mm. of platinum, and from the results of the cases described the conclusion is drawn that the radium treatment may be recommended to set free nerves or tendons included in cicatricial tissue, without any danger of forming fresh adhesions.—M. **Marage**: Contribution to the study of deafness resulting from war wounds. The deafness results from lesions of the auditive centres, either new or of a kind very rarely observed. These lesions are due either to direct shocks on the cranium or to a sudden displacement of air.—Henry D. **Dakin**: Certain antiseptic substances containing chlorine suitable for the treatment of wounds. In studying the germicidal power of antiseptics, it is necessary to take into account the effect of the presence of serum and proteid material in modifying the action. An antiseptic should be soluble, not precipitable by proteids, and possess a minimum toxic power and local irritating action. Hypochlorites fulfil some of these conditions, but are irritating and inconstant in composition. These two drawbacks can be overcome by using a solution of sodium hypochlorite prepared in a manner detailed. The sodium salts of benzene and toluene sulphochloroamides can also be advantageously used as antiseptics. Their aqueous solutions can be used under higher concentrations than hypochlorites, and are very slightly toxic.—R. **Anthony**: A brain of a fœtus of the gorilla.—Edmond **Bordage**: Histolytic phenomena observed during the regeneration of the appendices in certain Orthoptera.

BOOKS RECEIVED.

Elements of Finite Differences, also Solutions to Questions Set for Part I. of the Examinations of the Institute of Actuaries. By J. Burn and E. H. Brown. Second edition. Pp. 289. (London: C. and E. Layton.) 10*s*. 6*d*.

Mededeelingen van de Rijksopsporing van Delfstoffen. No. 6: The Pliocene Floras of the Dutch-Prussian Border. By Clement Reid and Eleanor M. Reid. Pp. 178 + plates xx. (The Hague: The Institute for the Geological Exploration of the Netherlands.)

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THURSDAY, AUGUST 26, 1915.

EVOLUTION: ORGANIC AND SOCIAL.

(1) *Evolution and the War.* By Dr. P. Chalmers Mitchell. Pp. xxv + 114. (London: John Murray, 1915.) Price 2*s.* 6*d.* net.

(2) *Societal Evolution: a Study of the Evolutionary Basis of the Science of Society.* By Prof. A. G. Keller. Pp. xi + 338. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 6*s.* 6*d.* net.

(3) *Symbiogenesis: The Universal Law of Progressive Evolution.* By H. Reinheimer. Pp. xxiii + 425. (London: Knapp, Drewett and Sons, Ltd., 1915.) Price 10*s.* 6*d.* net.

(1) DR. CHALMERS MITCHELL'S vivid book begins with an interesting personal preface concerning his relations (as student and expert and *Saturday Reviewer*) with Germany. The first chapter deals with war and the struggle for existence, and contains a destructive criticism of von Bernhardi's "great verity" that "war is a fundamental law of evolution." The second chapter refutes some of the widespread misconceptions of the struggle for existence, and is a timely corrective. Taking the instances of dingo replacing thylacine, of the alleged war to the death between brown rat and black rat, and of the competition of cockroaches, the author shows that the cases are rarely stated with accuracy, and that they do not substantiate the conclusion that an incessant internecine warfare obtains throughout nature. We think that Dr. Chalmers Mitchell draws his bow too tightly when he declares (p. 23) that the competition Darwin chiefly thought of is internal, amongst the individuals of a species; and on the other hand, that he would have strengthened his position by extending it, by recognising that the technical phrase "the struggle for existence" includes all the reactions (non-competitive as well as competitive) that living creatures make to the pressure and stimulus of environing limitations and difficulties.

The third chapter is devoted to showing that even if the struggle for existence were the law of organic evolution (an unacceptable way of putting it), modern nations are not units of the same order as those of the animal and vegetable kingdom. A modern nation is not unified by blood-relationship; a political community coheres "because of bonds that are peculiar to the human race."

The fourth chapter expresses a wholesome scepticism as to the degree in which the stock of a nation can be altered by selective or eliminative agencies. Thus the author does not share the dread that some biologists have expressed of the dysgenic effects of the present war. But we do not yet—alas!—know the limit of the sifting. The fifth chapter defends the proposition that

"The most important of the moulding forces that produce the differences in nationality are epigenetic, that is to say that they are imposed on the hereditary material and have to be re-imposed in each generation." "The environment of the body and the environment of the mind determine national differences."

What is said in regard to the importance of the environmental factor carries conviction, but when the author expresses his belief that "nurture is inconceivably more important than nature," he is opposing complementary, not antithetic, factors, and committing the same error as that which he condemns in the pronouncements of those who have said that in the case of man hereditary nature has "an overwhelmingly greater significance" than nurture.

The book closes, all too soon for our taste, with a fine and often eloquent statement of the author's position in regard to the apartness of man from other living creatures. Organically we are mammals and "rooted deep in the natal mud" (an ungrateful phrase), but

"Our possession of consciousness and the sense of freedom is a vital and overmastering distinction. For man is not subject to the laws of the unconscious, and his conduct is to be judged not by them, but by its harmony with a real and external not-self that man has built up through the ages."

We think again that the author draws his bow too tightly, but it is of great interest to find this "hard-shell Darwinian evolutionist, a lover of the scalpel and microscope, and of patient empirical observation, who dislikes all forms of supernaturalism, who does not shrink" (Heaven forfend us from not shrinking from such nonsense) "from the implications of the phrase that thought is a secretion of the brain as bile is a secretion of the liver," asserting "as a biological fact that the moral law is as real and as external to man as the starry vault."

No one ever quite agrees with his brother's philosophy, but we think that all readers of this little book (and may there be many of them!) will agree in gratitude to the author. For what he has said is marked with sincere and resolute thinking, and is especially valuable at the present time.

(2) Prof. Keller is convinced that any fruitful study of the science of society must rest on a clear understanding of the Darwinian theory, and,

furthermore, "that the Darwinian factors of variation, selection, transmission, and adaptation are active in the life of societies as in that of organisms." His aim is to discover how far societary variation, selection, transmission and adaptation are the same as organismal variation, selection, transmission and adaptation. He recognises, indeed, that adaptations in mankind have come to be mainly mental and external (for we transform our environment as much as we are transformed by it), but he goes back to the simple and fundamental "folk-ways," which "form the germ and matrix of all human institutions," and inquires whether these are "adaptive by way of the activity of factors of the order of those operative in organic evolution."

The beginning of evolution is variation, and societary variations arise from individual initiatives unconscious or conscious. If these are effective and are diffused, obtaining group-approval, they become part of the body of folk-ways or of a thought-out social policy. As social phenomena they are subjected to societary selection, which the author proceeds to analyse. There are many forms of group-conflict and inter-group conflict, from internecine life and death struggle at the one extreme to the antagonism between class-codes at the other, but, on the whole, the automatic societal selection is on a different plane from natural selection. For one thing, there is "a lack of that precision, exactitude, and finality characteristic of a nature-process."

Elimination is much less thorough and survival is in virtue of social rather than biological superiorities. But emerging out of these automatic forms of societal selection there is deliberate rational selection, which works by rational criticism of the arts of societal self-maintenance. The practical difficulty arises, however, that forms of societal selection may run counter to natural selection by favouring the survival of those who are, when judged by biological standards, relatively less fit. Under the title of "counter-selection," this difficult problem is shrewdly discussed, the author's general position being that a certain amount of counter-selection is, at present at least, inevitable, and that it is to be met by more carefully thought-out rational selection. Thus the dysgenic results of war may be met or mitigated by more attention to practicable eugenics.

Turning to societary transmission—notably of the folkways which persist from generation to generation—the author points out that psychical qualities are transmitted in the biological sense, but much more is effected by tradition, both by positive inculcation and by unconscious imitation. The resultant of societary variation, selection, and transmission is adaptation, which the last quarter of the book illustrates. The author seeks to show that folkways and institutions are established as adaptations to particular settings in time and place. In the Eskimos, for instance, he finds "a primitive and isolated society, a survey of whose mores indicates beyond question the close adaptation of the maintenance-mores to environmental conditions, and the consistency of the other mores with those of self-maintenance." Another illustration worked out is that of two types of frontier-societies, the one in the temperate zone and the other in the tropics. Finally, the author uses "the modern great city as the best example at hand after which to outline the adaptation of the mores to the artificialised environment."

The whole book is interesting and will be valuable to those who wish to clear up their ideas in regard to "societal evolution." There is at times a tendency to a discursive exposition of the obvious, and to what seems to us an unnecessary amount of quotation from the late Prof. Sumner (of whose work this essay is regarded by the author as an extension); the reader may also be troubled a little by the reiteration of the words "folkways" and "mores," and by the occurrence of others even less familiar, such as "acculturation," "ethnocentrism," and "aleatory," but these are trifles compared with the fact that Prof. Keller has made a stimulating contribution towards answering the question: How does evolution in societary forms agree with, and differ from, evolution among organisms, both in itself and in the factors that bring it about?

(3) Mr. Reinheimer's book is marked by seriousness of purpose, width of inquiry, and a grasp of several important truths; it is marred by a lack of scientific precision and restraint, and by a litter of quotations of diverse values which have not always been understood. The author discourses at length on many subjects, such as genetics, of which he betrays inadequate understanding, and we think that he writes a lot of nonsense about the "symbiogenetic" potency of "love-foods"—which are the by-products of plant-reproduction, such as dates, raisins, bananas, legumes and cereals, with milk and eggs thrown in.

"To eat pork, hare, and shellfish is certainly not in accordance with the grand symbiotic division of labour which has established itself as the normal rule of life, demanding cross-feeding in the best interests of this symbiosis. Such habits are, on the contrary, opposed to the normal order, and result in an inferior physiological currency establishing itself at the expense of a nobler currency. This cannot lead to symbiogenesis, but must lead to pathogenesis."

The author is on firmer ground when he illustrates the widespread occurrence of interrelations linking organisms to organisms in mutual dependence and influence. Symbiogenesis is defined (by no means clearly) as "the mutual production and symbiotic utilisation of biological values by the united and correlated efforts of organisms of all descriptions," and the author's thesis is that this principle underlies "all creative life, all progressive evolution."

It seems to us a defensible proposition that there has been throughout organic evolution a complexifying of interrelations in the web of life. For a recognition of this truth we have to thank Darwin more than anyone else; therefore while we agree with Mr. Reinheimer that the struggle for existence includes much more than internecine competition, we deprecate the clumsiness (or worse) of a sentence like this (p. 399):

"We may likewise excuse Darwin for making a sweeping metaphor do (substitute) service pending the lack of systematic study and knowledge concerning the fundamentally important co-operative (symbiotic) factors which, indeed, he had not entirely overlooked, though insufficiently appreciated."

On page 401 we notice that the name of a naturalist "of world-fame" is three times misprinted.

BOOKS ON COTTON PRODUCTION.

(1) *The World's Cotton Crops.* By Prof. J. A. Todd. Pp. xiii+460. (London: A. and C. Black, Ltd., 1915.) Price 10*s.* net.

(2) *The Development and Properties of Raw Cotton.* By W. Lawrence Balls. Pp. xii+221. (London: A. and C. Black, Ltd., 1915.) Price 5*s.* net.

WITHIN the past few years numerous books and technical reports have appeared on the subject of cotton. The latest contributions are the two volumes before us, and both authors obtained their practical inspiration direct from the cotton fields of Egypt.

(1) Prof. Todd furnishes a review of the past history and present-day world's supply, on the basis of the trade statistics of all cotton-producing countries. It should prove invaluable alike to merchant and planter. It is fully illustrated with views of the cotton fields, the methods of transport, as well as numerous local incidents of interest in planting life. It moreover furnishes a series of ten maps to show the countries of production, the cotton areas of each being indicated by patches of vivid green. We would venture the suggestion that in addition to denoting the localities of recent expansion it would have been of advantage had some system of shading been pursued to indicate relative importance. For example, the first map, which shows the Indian localities, gives the valley of Assam coloured as fully and deeply as are Berar or Gujarat; all three might therefore be assumed to be equally important. So, again, while Prof. Todd gives the cotton areas of the United States of America as (approximately) $35\frac{1}{2}$, India $24\frac{1}{2}$, and Egypt $7\frac{1}{2}$ million acres, the immense size of the green patch in the States conveys the impression of its being relatively larger than it is. It would have been a good plan, moreover, to have given numbers to the maps and to have shown these on the outside. In a like way we admit that trade names had to be given in a work of this nature, such as "Oomra-Wattee" (the modern Amraoti), but it would have facilitated reference had the orthography of the maps (Amraouati), at least, also appeared in the text.

An appendix affords what would seem to be full statistics (not always, we presume, easy to procure), and here brought into convenient form. A complete index has been given—a very necessary feature of a work of reference. The volume may be commended to persons in want of a book that deals briefly with every aspect of the commerce and agriculture of the world's cotton crop.

(2) Mr. Lawrence Balls's work furnishes the conclusions arrived at during an endeavour to improve the Egyptian cotton staple. If we differ from him in certain particulars we fully recognise the value of his labours. As a student of biology Mr. Balls has rendered a useful service, his contributions to the cytology and physiology of the cotton plant being welcome and of considerable importance. But in another branch of his studies he seems to have laboured under a delusion. It was unfortunate that the great urgency for research into the growth of the plant justified, in his mind, the setting on one side the results and evidences of systematic botany. He thus may be spoken of as having attempted to organise research on the exclusive basis of old pedigree selection and peripatetic Mendelian cross-breeding of undetermined stocks. In other words, he assumes that every investigator must deal with existing stocks and procure from these pure strains, but make little or no effort to derive new strains from internal or external sources.

As illustrative of Mr. Balls's disregard for the opinions of systematists it may be pointed out that he characterises scientific names as "merely useless duplicates of easier names." "Hindu-weed" is to Mr. Balls a name sufficiently explicit for all practical purposes. He, moreover, manifests a reckless use of terms that often proves most ambiguous if not misleading. The cotton plant belongs, so we are told, to "the sub-order Gossypiæ (or Hibiscæ)"—there is no such sub-order. Our author next admits that some conception of the genealogical tree of the cotton plant becomes necessary, and hence he affords us a description of what he regards as its original ancestor. He then proceeds to say: "At the present day certain wild cottons are found which represent the descendants of this primitive ancestor not so much altered, such as the wild species *Gossypium sturtii* in Australia." "Not so much altered," and yet the wild species mentioned manifests a direct negation of practically every one of the characteristics of Mr. Balls's presumed primitive ancestor of cotton! It is thus hopeless to attempt to follow him into speculations of "cleavages" that gave rise to his "Asiatic," "Peruvian," and "Uplands" groups. "The grouping," he says, "of all species of cottons of the Peruvian type, for example, into groups of relations, each group being designated a sub-species." By another enigma a sub-species becomes a hybrid.

"The Indian group," we are told, "does not appear to cross with the Upland or Peruvian groups." That statement is given more than once, and its value obviously turns on the plants accepted as Indian, Upland, and Peruvian. It is, however, a fact that a cross has been obtained repeatedly, both in India and America, between an Indian and an American plant.

Why did not Mr. Balls furnish his readers with a botanical drawing of each of the chief plants investigated by him, or at all events with drawings of his three great divisions of which he has so much to say? His plates iii. and iv. are useless for that purpose.

We have felt it incumbent to exhibit the weak side of Mr. Balls's work, but we turn with pleasure to other portions of his book. The chapter on the Egyptian plant (as recognised by the author) is admirable. It sets forth in a vivid manner the different conditions of soil, water, and temperature that prevail in that country. He thus exemplifies the conditions that it would seem must exist before Egyptian stock can be successfully acclimatised in other countries.

The chapter on "Development of the Boll," though full of interesting details, is less practical than it may be presumed the author anticipated it might prove. Mr. Balls's method of investigating (and estimating) the productiveness of the plant, of testing the strength, as also of measuring the length of the fibre, are certainly clever and seem practical. But his chapter on the "Commercial Lint" confirms the necessity for critical study of all the races of the plant. The appendix affords a very much-needed key to Mr. Balls's methods of research, and is distinctly useful.

PLANT-LIFE IN SOUTH AFRICA AND CALIFORNIA.

(1) *Plants and their Ways in South Africa.* By Prof. B. Stoneman. New edition. Pp. xii + 387. (London: Longmans, Green and Co., 1915.) Price 5*s.*

(2) *The Ferns of South Africa, containing Descriptions and Figures of the Ferns and Fern Allies of South Africa.* By T. R. Sim. Second edition. Pp. ix + 384. Plates. (Cambridge: At the University Press, 1915.) Price 25*s.* net.

(3) *With the Flowers and Trees in California.* By C. F. Saunders. Pp. xii + 286. (London: Grant Richards, Ltd., 1914.) Price 7*s.* 6*d.* net.

(1) THE author of "Plants and their Ways in South Africa" has produced a useful text-book for the South African student of botany, a companion, that is to say, to class and practical work under supervision. A study of the seed and its germination leads on to the consideration of the growth of roots, stems and leaves, and of the duration of life of the plant. The form and structure of the parts, with a brief section on cells and tissues, is followed by a series of chapters on function. The chapter on the leaf is rather mechanical, and its subject-matter might with advantage have been more intimately associated with the portions dealing with plant-physiology. The study of the flower and fruit is associated with pollination and seed-distribution; and there is a short chapter on the remarkable Kukumakranka, a small bulbous plant belonging to the Amaryllidaceæ. The remainder of the book, comprising about one-half of the whole, is devoted to a sketch of the classification of plants, mainly the seed-bearing plants, with concise descriptions of those families and their representative genera which occur in South Africa. A short concluding chapter deals with the botanical regions of South Africa. The book is profusely and well illustrated with blocks, both original and borrowed from various sources.

(2) The first edition of Mr. Sim's "Ferns of South Africa" appeared in 1892, and was reviewed in NATURE of January 26, 1893. In the twenty-three years which have elapsed since, the exploration of the country north of the Orange, Vaal, and Umvolosi rivers and the opening up of Southern Rhodesia have added greatly to our

knowledge of the fern flora of the reconstituted South Africa. Hence the new edition of the book enumerates 220 species, as compared with 179 in the first edition, and, the author states, this number should be further increased when the northern Drakensberg ranges, the Portuguese mountain slopes, and the valleys of the Zambesi, have been more closely investigated. Mr. Sim has taken the opportunity of revising the nomenclature, which now follows Christensen's *Index Filicum*, and thus renders the volume comparable with recent fern literature. The arrangement adopted by Christensen is also followed in the classification of the ferns proper, that is, exclusive of the Lycopods, Psilotum, and Equisetum.

Of the introductory chapters, that on "Cultivation" has been rewritten and much extended; but there is room for a good chapter on the general life-history of a fern, which is at present somewhat scrappily treated. The plates are more numerous, 186 as against 159, and on the whole better, than in the first edition, and the general get-up of the book, which is now issued by the Cambridge Press, is also greatly improved.

(3) "With the Flowers and Trees in California" is a delightful series of word-pictures descriptive of the plant-life of one of the most brilliantly floriferous regions on the face of our earth. In a series of thirteen chapters, Mr. Saunders describes as many phases of his subject from first-hand knowledge. There is no definite plan, each chapter is complete in itself, and, open it where he will, the botanist or intelligent general reader will find matter of interest charmingly portrayed. The first chapter is retrospective: an attempt to depict the virgin flora as it appeared to the first white men who visited the country, the Portuguese navigators, and later the Padres, who were the earliest settlers. Some account is also given of early botanical explorations, especially of David Douglas, who introduced to European gardens so many Californian flowers and trees; the Yorkshireman, Thomas Nuttall; and the American, John Fremont. The author does not overstate the case when he says that "the value of annuals in horticultural effect was first realised when the Royal Horticultural Society of London sowed the seeds of the scores of beautiful annuals which their collector, David Douglas, back in the 1830's, brought them from California," and "the gardens of Europe are full of California wild flowers, such as clarkias, lupines, gilias, eschscholtzias, godetias, penstemons," and, best known of all, nemophila. Intimately associated with Douglas also are some of the finest conifers, which he discovered in the West American forests, *Pinus lambertiana*, the Douglas pine (*Pseudotsuga douglasii*), and many others.

The story of Californian plant life would not be complete without mention of the Big trees, and the chapter entitled "The Sequoia and its Adventures in Search of a Name" gives a racy account of the red-wood and its ally, the *Sequoia gigantea*, and the vicissitudes connected with the botanical name of the latter. If California has been generous she has also proved hospitable, and her wayside trees have been brought from all quarters of the globe; one may mention among many various palms, New Zealand cordylines, Australian eucalyptus, acacias, and casuarinas, and the widely-spread pepper-tree (*Schinus molle*), a native of Peru: as "the professor" remarks, "a walk along a California avenue is like a trip round the world." "Tree-hunting on a California desert" depicts another phase, and introduces the reader to the yuccas, mesquit, cacti, and brilliant-flowered shrubs of the desert. A few daintily coloured plates and a number of half-tone illustrations enhance the value of an interesting and eminently readable book.

THE FLY PEST.

(1) *Fighting the Fly Peril.* A Popular and Practical Handbook. By C. F. Plowman and W. F. Dearden. Pp. 127. (London: T. Fisher Unwin, Ltd., 1915.) Price 1s. net.

(2) *The House Fly: A Slayer of Men.* By F. W. FitzSimons. Pp. vi+89. (London: Longmans, Green and Co., 1915.) Price 1s. net.

(1) THIS volume is practically an exposition in popular terms of the use of borax as a destroyer of the eggs and larvæ of the house fly, with suitable quotations from Gordon Hewitt and other writers. The use of traps, of formalin, of some general precautions is also advocated. The authors lay stress on the importance of covering manure with soil, but it is not clear how far this will affect its rotting and so its manurial value.

Above all, the authors recommend borax, using the matter in Bulletin 118 of the United States Department of Agriculture and adducing an experiment of their own. We pass over the American bulletin, since it is now recognised in America that borax is not a suitable material for preventing fly-breeding in manure heaps. The "British Experiment" of chapter ix. is of interest, as it goes completely contrary to experiments made in this country on a much larger scale. This experiment was made in three tea boxes, with three cubic feet of manure in each. Flies hatched out from the untreated manure, not from the treated. It is noticeable that flies began to emerge on the eighth day from the untreated manure: they must therefore have been there as larvæ from the beginning. The claim that the borax killed eggs is then untenable.

There is no information as to the number of maggots in the manure to start with, the temperature of the manure (a very important point), or the comparative temperatures of each lot. Practically, the book depends on one experiment, carried out under doubtful conditions and contrary to much larger experiments made here. We regret it, as it will mislead many, and lead to much useless employment of borax.

(2) The second volume is an attempt to get people to realise that the house fly is a real danger and to persuade them to cope with it. "Knowledge is power only when it is turned to practical use" is the opening to chapter vii., and we could quote other sentences full of meaning that occur in it.

The remedies advocated in it are usually sound and practical. Like others, the author fails to realise that the fly maggots live in material that is actually fermenting and in manure heaps that are hot, and that in consequence a purely superficial treatment will often kill them. It is also not true to say that "an insecticide to kill maggots must be about four or five times as strong as that used against other kinds of insects": it must be different, that is all.

The various chemical treatments recommended (salt, sodium arsenate, Paris green, sulphate of iron, etc.) are not practical for manure, nor are they cheap, and it would be interesting to know exactly what evidence there is of their effectiveness. Apart from this, the reader will find the book sound and helpful. It is written for South Africa, and all the methods advocated would not suit this country.

A chapter is devoted to the stable fly, which is possibly a disseminator of infantile paralysis. This chapter has special value now in England, as the stable fly is sometimes the only fly common in seaside resorts where children swarm, and most people, quite naturally, do not differentiate it from the house fly. When these matters are more fully investigated the importance of the stable fly will be settled. Meanwhile it is worth remembering that when people think that the house flies are biting them, in autumn, it is really the stable fly.

Of the two volumes we prefer the second, and we know of no other volume that is quite so simple, sensible, and practical. To those who wish to realise what the fly is, or does, without unnecessary scientific details, we commend this little book.

H. M. L.

OUR BOOKSHELF.

A Descriptive Monograph of Japanese Asteroidea, Part I. (Journal of the College of Science, Imperial University of Tokyo. Vol. xxix., Art. i. December 17th.) Pp. 808+xix plates. (Tokyo: The University, 1914.)

In this large volume of about 800 pages only the Phanerozonia of Japan are included. Fifty-nine species are described, of which eighteen are new. The descriptions, in the case of thirty-nine species, are based on an examination of a number of collections preserved in various Japanese Institutions; but in the case of twenty species, which are not represented in any of the indigenous collections, either the extant description of the original author is quoted, or the species is very honestly expounded in a series of extracts from the several authors, who at different times have discussed and criticised it, in such a way that its definement suffers no perdition. The autoptical descriptions are excellent: they are clear and discriminative, and though rather tending to be meticulous, are far from being tedious or discursive. But in dealing with the history and literature of the subject the author is inclined not only to a redundance of quotation which is largely iterative, but also to burdening the quotations with a superfluity of their unimportant detail. Seeing that there is provided an exhaustive bibliography, filling over 100 pages, and concerned exclusively with papers cited in the text, this multiplication of undigested extracts descriptive of one and the same species is wearisome and unnecessary, though, of course, there are some who would not regard this feature as in any way a defect. On the whole, however, it must be allowed that this monograph is a wonderful piece of solid, honest work, the very card and calendar of taxonomy, and fit to stand among zoological works of reference of the very highest class. The typography is excellent, and there are nineteen double plates of admirable illustrations in photogravure.

In the copy under review pp. 81 to 86, which would appear to relate to *Ctenodiscus crispatus*, are wanting, and in their place pp. 97 to 112 are duplicated.

The Health of the Child: A Manual for Mothers and Nurses. By Dr. O. Hildesheim. Pp. xii+111. (London: Methuen and Co., Ltd., 1915.) Price 1*s*. net.

The introduction to this work is written by Dr. G. F. Stell, the well-known Professor of Diseases of Children at King's College Hospital, and when he praises it, it is a work of supererogation of a mere reviewer to say ditto. The feeding, clothing, washing, nursing, and early education of the infant are all treated with admirable clearness and sound common-sense. The underlying doctrine that cleanliness and godliness are akin, if not identical, is forcibly pressed home. The book may not only be placed safely in the hands of every mother and nurse, but it seems almost unsafe to allow any mother and nurse to be without this excellent shillingsworth.

W. D. H.

LETTERS TO THE EDITOR.

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

The Analogy between Radicles and Elements.

THE remarkable chemical analogy of the ammonium radicle and the alkali metals may be explained with the help of Bohr's theory of atomic structure. According to Bohr, the atom of nitrogen consists of a nucleus with a positive charge of $7e$, surrounded by two rings of electrons, the inner containing 4, the outer 3 electrons. N is, therefore, represented by 7 (4, 3). Ordinary chemical compounds are supposed to be held together by rings of electrons rotating in planes perpendicular to the lines connecting the nuclei of the composing atoms; so that NH_3 may be represented by (4, 3 − 3). This principle leads, however, to difficulties, if applied to NH_4; a configuration (4, 3 − 4) seems impossible. It is better to suppose the nuclei and electrons to rearrange themselves within the atom. I assume, therefore, that the nuclei unite, or at least that they get quite close to each other, in the centre of the system, while the electrons arrange themselves in four rings (4, 4, 2, 1), rotating round the joined nuclei. It may seem difficult to bring the nuclei together against the repelling forces, but it must be remembered that the radicle NH_4 can only be formed by indirect methods; in no circumstances will ammonia and hydrogen unite to form NH_4. The co-operation of another molecule containing hydrogen, like H_2O, HCl, is absolutely necessary, an intermediate compound first being formed, from which the ammonium-ion is produced by electrolytic dissociation. Once liberated, the ammonium decomposes immediately; it is extremely unstable, exactly conforming to our expectations. It is also important to remark in this connection, that, according to Coehn, electric charges are given off during the decomposition.

The arrangement proposed at once shows analogies with Bohr's representation of Na (8, 2, 1) and K (8, 8, 2, 1). These two configurations contain the same outer rings as NH_4 and differ only with regard to the inner rings. The number of electrons in Na and NH_4 is even the same; in K and NH_4 we find the same number of rings. The second similarity seems to be of primary importance, ammonium resembling potassium more closely than sodium. The fact that the analogy does not go further than the chemical properties follows at once from the general principle that the chemical character of a substance depends only on the outer rings.

The same considerations apply, of course, to PH_4, which, however, is only known as an ion, and AsH_4, and perhaps to hydrazine, which shows some resemblance to calcium. Whether the substituted ammonium bases may also be drawn within their scope is not yet settled.

There is still another line of thought to which I wish to direct attention. In the periodic table nitrogen is placed in the fifth group. When it combines with four hydrogen atoms, according to the above hypothesis, the nucleus charge increases by $4e$; the resulting radicle is analogous to a metal of the first group, *i.e.* to an element which occupies the *fourth* place on the right of the original element. This is exactly the reverse of the radio-active transformations in which by the loss of an α particle ($2e$) the atom removes two places to the left.

This idea may also be applied to the analogous sulphur and iodine bases. Although these are only known in compounds, in which the hydrogen atoms are substituted by aliphatic or aromatic radicles, we shall take for discussion the fundamental types; instead of SR_3OH and IR_2OH, we consider the radicles SH_3 and IH_2. SH_3 also has the chemical properties of an alkali metal. Now, sulphur is placed in the sixth group; if the nucleus takes up three elementary charges, $3e$, the atom shifts its position by *three* places to the right, and arrives in the first group, thus confirming the general law. Also, the change of the iodine atom (seventh group) by taking up two hydrogen atoms, $2e$, is an agreement with the theory, for the iodonium radicle also exhibits the properties of a strong base. Iodonium, it is true, especially resembles thallium, but it is known that thallium and silver are closely similar; so iodonium also fits in the first group.

The above considerations may be extended to cyanogen and the halogens, which also show a striking resemblance. Though cyanogen is not unstable, it is not easily obtained. Its formation is only possible at high temperatures, and in the presence of alkalis, or by the use of electric discharges. It is a strongly endothermic compound. The structure of the CN radicle may be represented by 13 (4, 4, 4, 1), whilst Bohr writes fluorine 9 (4, 4, 1), and chlorine 17 (8, 4, 4, 1).

E. H. BUCHNER.
Chemical Laboratory, University of Amsterdam,
July, 1915.

The Density of Molecules in Interstellar Space.

IN recent years evidence has been brought forward by several investigators[1] indicating that light from distant stars suffers a slight attenuation in travelling through interstellar space. In particular a recent investigation by Jones[2] assigns fairly definite numerical values to coefficients of attenuation corresponding to "photographic" and "visual" light from stars of known proper motions and spectral types the magnitudes of which had been carefully measured by Parkhurst[3] for light of these wave-lengths. If, as seems reasonable, this extinction is assumed to be due to attenuation by scattering in travelling through a "residual" gas occupying interstellar space, we are enabled to estimate the average density of molecules in the intervening regions, following a method due originally to Larmor[4] for assigning an upper limit to the density of matter in comets' tails.

If we denote by κ the coefficient of attenuation corresponding to wave-length λ, radiation of this wave-length originally of intensity E_0 is reduced, after travelling a distance x, to the value given by $E = E_0 e^{-\kappa x}$. According to Rayleigh's law of molecular scattering, κ is given in terms of the refractive index μ, and the molecular density of the medium n by the relation $\kappa = \frac{8}{3}\pi^3(\mu^2 - 1)^2\lambda^{-4}/n$. The ability of Rayleigh's law to account almost completely for the attenuation of solar radiation in travelling through the earth's atmosphere was first pointed out by Schuster[5]; a later investigation by the writer,[6] based on the results of the Smithsonian Astrophysical Observatory, indicated that formulæ based on this law were competent to explain atmospheric extinction as well as to account quantitatively and qualitatively

1 Kapteyn, J. C., *Astrophysical Journal*, xxix. (1909), pp. 46–54; xxx. (1909), pp. 284–317 and correction p. 398. Turner, H. H., *Monthly Notices* Roy. Ast. Soc., lxix. (1909), p. 61. King, E. S., *Harvard Annals*, lix., No. 6, p. 179, April, 1911; *Harvard Annals*, lxxvi., No. 1, pp. 1–10. 1913. Brown, F. G., *Monthly Notices*, lxxii. (1912), p. 195, also p. 718.

2 Jones, H. S., *Monthly Notices* Roy. Ast. Soc., lxxv (1914), pp. 4–16.

3 Parkhurst, J. A., "Verkes Actinometry," *Astrophysical Journal*, xxxvi. (1912), p. 160.

4 Larmor, Sir J., Lectures, Cambridge, 1908.

5 Schuster, A., NATURE, July 22, 1909; "Optics," 2nd Edition, 1909, p. 329.

6 King, L. V., Phil. Trans. Roy. Soc., ccxii.A (1912), pp. 375–433.

for the intensity and distribution of sky-radiation as far as the observations available at that time could be tested. As a final test, the Smithsonian results were reduced with a view to obtaining a value for the number of molecules per cm.^{3} of a gas at standard temperature and pressure; the result obtained by the writer,[7] $n_0 = (2{\cdot}78 \pm 0{\cdot}01) \times 10^{19}$, and a later independent determination by Fowle,[8] $n_0 = (2{\cdot}70 \pm 0{\cdot}02) \times 10^{19}$, indicate that we may rely with confidence on Rayleigh's law in dealing with molecular extinction for wave-lengths not too close to regions of selective absorption.

In dealing with attenuation in a stellar distance $x = \Delta$, the term $\kappa\Delta$ is so small that we may write to sufficient degree of approximation $\kappa\Delta = (E_0 - E)/E_0$, *i.e.* $\kappa\Delta$ is the proportional loss of intensity in travelling a distance Δ. Denoting by $\kappa_1\Delta$ and $\kappa_2\Delta$ the proportional losses of intensities corresponding to "photographic" and "visual" light of average wave-lengths λ_1 and λ_2 respectively, we derive on reducing to intensities the result obtained by Jones,[9] [(photographic) − (visual)] losses = $+0{\cdot}00473 \pm 0{\cdot}00035$ magnitude, the relation $(\kappa_1 - \kappa_2)\Delta = 0{\cdot}00435 \pm 0{\cdot}00032$, the distance Δ being 10 parsecs (1 parsec = distance corresponding to a stellar parallax of $1'' = 3{\cdot}26$ light-years $= 3{\cdot}08 \times 10^{19}$ cm.). If it is assumed that the extinction is brought about solely by molecular scattering, we also have the additional equation $\kappa_1/\kappa_2 = (\lambda_2/\lambda_1)^4$.

Unfortunately, it is somewhat difficult to assign with accuracy the average wave-lengths corresponding to "photographic" and "visual" light. A rough estimate by the writer from Parkhurst's curves of spectral intensities corresponding to the plates and filters employed in the photographic and visual determinations yielded the values $\lambda_1 = 0{\cdot}446\mu$ and $\lambda_2 = 0{\cdot}533\mu$, so that we obtain $\kappa_1/\kappa_2 = 2{\cdot}08$, giving $\kappa_1\Delta = 0{\cdot}0083_8$ and $\kappa_2\Delta = 0{\cdot}0040_3$.[10] In order to realise more vividly the extremely small attenuation which these numbers represent, it is easily verified that in order to lose one-tenth of its original intensity radiation of these wave-lengths must travel for about 4·1 and 8·5 centuries respectively.

For the purposes of the present discussion we assume hydrogen to be the constituent of interstellar space (until we know more about the physical properties of "coronium," "nebulium," or other primordial gases which might possibly occupy these regions). Taking $\mu_0 - 1 = 0{\cdot}000140$, $n_0 = 2{\cdot}78 \times 10^{19}$, $\lambda = 4{\cdot}46 \times 10^{-5}$ cm., we easily derive for the coefficient of attenuation in hydrogen at standard temperature and pressure the value $\kappa_0 = 5{\cdot}89 \times 10^{-8}$ cm.$^{-1}$. For this wave-length in interstellar space we have $\kappa = 2{\cdot}72 \times 10^{-22}$ cm.$^{-1}$, so that $n/n_0 = \kappa/\kappa_0 = 4{\cdot}62 \times 10^{-15}$, giving finally for the molecular density in interstellar space the estimate $n = 1{\cdot}28 \times 10^5$ hydrogen molecules per cm^3.[10]

Associated with the problem of attenuation by scattering is that of calculating the amount of starlight scattered by the molecules of interstellar gas.[11] In this way might be explained the extremely faint luminosity which several observers believe to exist over the background of the sky. This scattered light might also account for discrepancies which have been found to exist between calculated and observed distributions of total starlight from different regions of the night sky.[12] The estimation of the amount of solar radiation scattered to the earth by a distribution of interstellar gas constitutes a definite problem, the complete statement of which (including the effect of self-illumination) is expressed as a particular case by a general integral equation already given by the writer.[13] The theoretical discussion applicable to the problem under discussion the writer hopes to undertake elsewhere; from the observational point of view it would seem that the difficult, but perhaps not impossible, task of estimating the luminosity of the sky in regions void of stars affords the only hope of bringing additional direct evidence to bear on some of the questions raised below.

In a gas of the extreme degree of tenuity which we have just estimated, molecular collisions will be extremely infrequent; an estimate of the free path, according to the usual ideas of the kinetic theory, is impossible without a knowledge of the average molecular velocity or temperature of the gas. As has already been pointed out by the writer,[14] it is difficult to see how molecular velocities can be directly affected by radiation travelling through a gaseous medium. It is probable that gravitation and radiation-pressure are the controlling forces in determining molecular velocities by an extremely slow process of equipartition of energy with that of molecules escaping from planetary and stellar atmospheres.

As the above estimate of molecular density gives a total amount of matter of the order $1/38 \times$ earth's mass in a sphere having a radius equal to that of Neptune's orbit, it is improbable that the residual gas we are considering could have a noticeable effect on planetary motions. It might, however, be identified with the slightly resisting medium the existence of which has been thought necessary by some astronomers to account for the secular acceleration of Encke's comet,[15] and which is considered by See[16] to have played an important *rôle* in planetary and stellar evolution.

The molecular density estimated above is very much less than that conjectured to exist in some of the nebulæ, 10^9 molecules per cm.^{3} being about the order of magnitude in this case.[17] While the degree of rarefaction which we have derived is very much greater than it is possible to produce by any known physical means,[18] the total amount of matter contained in regions of space of astronomical dimensions is formidable; thus we find for the number of molecules in a cubic parsec the estimate $N = 3{\cdot}75 \times 10^{60}$ hydrogen molecules per parsec^3. Taking the density of hydrogen at standard temperature and pressure to be 0·0899 gramme per litre (containing $2{\cdot}78 \times 10^{22}$ molecules), we obtain for the density of matter in interstellar space the estimate $1{\cdot}21 \times 10^{37}$ grammes per parsec^3; as the sun's mass is approximately $1{\cdot}96 \times 10^{33}$ grammes, we have finally for the density of interstellar residual gas the estimate $6{\cdot}3 \times 10^3$ sun's mass per parsec^3. According to Eddington,[19] a reasonable

[7] King, L. V., NATURE, xciii. (July 30, 1914), pp. 557–559.

[8] Fowle, F. E., *Astrophysical Journal*, xl. (December, 1914), pp. 435–442.

[9] Jones' determination is in fair agreement with Kapteyn's final result, (*Astrophysical Journal*, xxx., p. 398):

[(photographic)—(visual)] losses = $+0^{m}{\cdot}0031 \pm 0{\cdot}0006$.

The corresponding determinations by King (E. S.) of the coefficients of attenuation for photographic and visual light give values about five times that of the text.

[10] The losses $+0^{m}{\cdot}0080$ and $+0^{m}{\cdot}0033$ estimated by Jones for "photographic" and "visual" light lead to the values $K_1\Delta = 0{\cdot}0073$ and $K_2\Delta = 0{\cdot}0030$ (wave-lengths not stated). Kapteyn's (corrected) estimate for wave-length $\lambda_1 = 0{\cdot}431\mu$ is $K_1\Delta = 0{\cdot}0050_7$, leading to the value $n = 0{\cdot}68 \times 10^5$ hydrogen molecules per cm.^{3}, which is of the same order of magnitude as the determination already made. E. S. King's results (footnote 1) increase the estimate of the text about five fold.

[11] Note a discussion on this point by H. C. Plummer in a paper by H. H. Turner, *loc. cit.* (footnote 1).

[12] Abbot, C. G., *Astronomical Journal*, xxvii. (1911), p. 20; "Annals of the Smithsonian Astrophysical Observatory," vol. iii. (1913), pp. 203–210.

[13] King, L. V., footnote (6), p. 379, equation (14).

[14] King, L. V., footnote (7).

[15] On the recent history of this comet see a paper by Backlund, "Encke's Comet, 1805–1908," *Monthly Notices*, lxx. (1910), pp. 429–442.

[16] See, T. J. J., "Researches on the Evolution of the Stellar System," 1910, vol. ii., pp. 134–158.

[17] Henkel, F. W., in an article "Nébuleuses et Essaims," *Scientia*, vol. xv. (1914), pp. 294–307.

[18] The total number of molecules per cm.^{3} corresponding to the vapour-pressure of mercury at the temperature of liquid air is estimated at 3×10^7 (Dunoyer, M. L., "Les Gaz ultra-raréfiés," in the collection "Les Idées Modernes sur la Constitution de la Matière," Paris, Gauthier-Villars, 1913, p. 216).

[19] Eddington, A. S., "Stellar Movements and the Structure of the Universe." Macmillan and Co., Ltd., 1914, p. 255.

estimate of the density of visible stars in the neighbourhood of the solar system is 10 × sun's mass in a sphere of 5 parsecs radius (525 parsec³), *i.e.* 0·019 × sun's mass per parsec³. It follows that the density of "uncondensed" or "residual" matter existing in interstellar space is of the order 10^5 that of "condensed" stellar matter. Even if, as there is some reason to believe, the number of "dark" stars is very much greater than the number of bright ones (Lindemann's estimate is 4000),[20] the ratio referred to is still very large.

It is evident that unless this "residual" or "primordial" gas is exempt from mutual gravitation[21] it must give rise to a gravitational field very much greater than that of the whole sidereal universe, and should therefore be taken into account in existing theories of stellar dynamics. Although the dynamics of such a system would probably have to be modified to a considerable extent to take into account radiation pressure, we should still expect an enormously high density near its mass-centre, unless the whole be endowed with a small angular velocity, as is surmised to be the case with the Milky Way.

It follows from this brief discussion that we are either obliged to accept the existence of a widespread distribution of enormous quantities of interstellar gas of molecular density of the order 10^5 molecules per cm.³ and take into account its influence in stellar dynamics, or conclude that the attenuation of light by scattering is very much less than is indicated by existing estimates of the absorption of stellar radiation in space.

LOUIS VESSOT KING.

McGill University, Montreal, June 30, 1915.

[20] Lindemann, F. A., "Note on the Number of Dark Stars," *Monthly Notices*, lxxv. (1915).

[21] On this point note a remark by Eddington, *loc. cit.*, p. 258.

The Great Aurora of June 16, 1915.

IN reply to Dr. Chree's note in NATURE for July 22 concerning the auroral display of June 16, I would say that the times (as indicated in my note in NATURE for July 15) were in Greenwich Mean Time. This, of course, begins at Greenwich Mean Noon. It did not occur to me that this might be misleading to the unastronomical reader. If one will subtract twelve hours from the times given by me, he will then have the dates for the morning of June 17 at Greenwich. Thus June 16d. 15h. 30m. G.M.T. will be June 17d. 3h. 30m. a.m., Greenwich Civil Time.

I will take the opportunity to quote here from the Los Angeles (Cal.) *Tribune* of June 18, 1915, a despatch from Chicago dated June 17:—

"Chicago telegraph operators were puzzled to-day when their wires failed at times to work. Soon, however, the explanation of the trouble came. It was not due to power stations or lack of current, but to the aurora borealis.

"The bewildering beauty of the northern lights lighted up all of Canada and the north-western part of the United States last night and caused electrical disturbances that put telegraph wires entirely out of commission in Idaho, Montana, and the Dakotas and along the Canadian Pacific railroad.

"The disturbances extended to Chicago to-day and to-night, and reports of trouble between Pittsburgh and New York, St. Louis and Kansas City, and many other cities over the country, were received. Operators here stated to-night that the disturbance was the worst they had known in five years.

"W. F. Weber, wire chief for the Western Union, reported service considerably demoralised.

"'Our wires the whole length of the land were badly affected early to-day,' he said. 'They are affected still, though not to such a degree. The disturbance of the atmosphere causes fluctuation of the current on the wires, and interferes with rapid transmission of signals. We have been obliged to operate at a much lower speed than normal to-day.'

"The Postal Telegraph Company was similarly affected.

"It also was reported that train-dispatching on the Canadian Pacific railroad virtually ceased for several hours. Similar conditions prevailed on other northern transcontinental lines."

E. E. BARNARD.

Yerkes Observatory, Williams Bay, Wisconsin, August 4.

Use of Celluloid in Periscope Mirrors.

I SHOULD be glad to know, in reference to the possibilities of diminishing the danger in using periscopes under fire: (1) whether experiments have been tried as to the effect of cementing a plate of celluloid to the back of the exposed mirror in preventing or reducing the splintering of the glass when struck by a bullet, and, if so, with what result; (2) whether there is any danger involved in the use of celluloid for this purpose?

EDWARD M. LANGLEY.

48 Waterloo Road, Bedford, August 17.

Foreign Philosophers.

ONE of the original objects of our Association for the Advancement of Science was to encourage the exchange of ideas with foreign philosophers, *vide* First Report of B.A. This year it will be a disappointment to many people in Manchester to have so few distinguished strangers. We now call them prisoners of war or alien enemies. But they still wish for scientific enlightenment.

Inquiries made in the prisoners' camp at Stobs reveal a small library carefully catalogued. They have some hundreds of English books, including some scientific books; also, in German, Schiller and Goethe. They ask particularly for Naturwissenschaft in Deutsch, Chemie, Physik, Geologie, Botanik, also agriculture (Landwirthschaft), navigation, engineering, mathematics, mathematical astronomy for seamen, logarithms, Electrotechnik. There are repeated inquiries for a German book on spherical trigonometry, enough copies for the navigation class.

The requests we have the honour to transmit may be satisfied by sending books direct to Von Vorman, Librarian, Prisoner of War, Hut 18, Compound A, Stobs, near Hawick, Scotland. Inquiries as to books likely to be welcome in other camps may be addressed to the Emergency Committee, 169 St. Stephen's House, Westminster Bridge, S.W.

Some of the prisoners have already expressed a general willingness to remind their friends in Germany (with whom they are privileged to communicate) that the English prisoners in German camps are also asking for books.

Books sent by passenger train should be carriage paid, by parcels post they go free of charge.

August, 1915. HUGH RICHARDSON.

French Magnanimity.

FRENCH history furnishes an interesting parallel to the magnanimity shown by Napoleon to the University of Pavia referred to in your issue of July 15. When Rudyerd was engaged in building the second Eddystone Lighthouse a French privateer captured some of his workmen and carried them prisoners to France. Louis XIV., however, as soon as he heard of it, put the captain and crew in prison, released the workmen, loaded them with presents, and sent them home, saying that though he was at war with England, he was not at war with mankind.

GORDON D. KNOX.

11, Garrick Street, W.C., August 17.

ANTARCTIC FOSSIL PLANTS.[1]

PROF. SEWARD'S Memoir is the first of the British Museum Reports dealing with the natural history results of Capt. Scott's second Antarctic expedition. The work is finely illustrated, and provided with excellent maps. The specimens described are of unequalled interest among fossil plants, from their occurrence so near the Pole, and from the tragic circumstances of their discovery.

The report begins with a few notes on palæobotanical records from previous expeditions. Though of considerable interest as demonstrating the former existence of vegetation on the Antarctic Continent, these earlier records were of little botanical value, none of the specimens admitting definite determination. The really important Antarctic specimens of fossil plants are among the fruits of Capt. Scott's second expedition.

FIG. 1.—The medial moraine on the Priestley Glacier. From "Antarctic Fossil Plants," by A. C. Seward, F.R.S.

The petrified remains of a tree, named by the author *Antarcticoxylon priestleyi*, were discovered by the northern party on February 1, 1912, on the moraine of the Priestley Glacier, south of latitude 74° S. Still more important discoveries were made by the Polar party at Mount Buckley in latitude 85° S., on February 8, 1912 (see our illustration). This was on their sad return journey and less than six weeks before the end. The "beautifully traced leaves in layers" found in "veritable coal-seams" in the Beacon Sandstone, are found to belong to the well-known species *Glossopteris indica*, which is thus shown to occur in abundance only about 300 miles from the South Pole. The fact that there is some evidence of drifting does not materially affect the interest of this astonishing discovery. The nature of the plant is beyond doubt, as shown by the excellent photographs, and the finding of so well-characterised a member of the Gondwana Flora was peculiarly fortunate. The stems and scale-leaves of Glossopteris also appear to be present.

The fossil wood, *Antarcticoxylon priestleyi*, from the Priestley Glacier, is described in full detail, with the aid of numerous microphotographs; an interesting point is the presence of well-marked annual rings. The occurrence of concentric bands of cellular tissue in the wood is a peculiar feature, possibly to be explained as a reaction to wounding during life. The wood shows affinity with that of Cordaites, but is regarded as the type of a new genus.

The author might perhaps have compared his specimens with *Mesopitys tchihatcheffi*, a Permian plant from the Altai, fully described by Zalessky in 1911; the two stems have a good deal in common, notably in the presence of annual rings, the single leaf-traces and the structure of the primary wood.

Other, less well preserved, specimens of Antarctic wood are all regarded as probably Gymnospermous.

A curious discovery is that of a body (*Pityosporites antarcticus*) apparently representing a winged pollen-grain; it was found in the matrix of a partially decayed stem of Antarcticoxylon. Winged pollen-grains occur both in the Firs and the Podocarpineæ; on geographical grounds the latter group appears the more probable, but the agreement with the pollen of the Abietineæ seems to be closer.

[1] "Antarctic Fossil Plants." By A. C. Seward, F.R.S. British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Geology, vol. i, No. 1, pp. 1-49+viii plates. (London, 1914.) Price 6*s*.

FIG. 2.—Buckley Island from the Beardmore Glacier. From "Antarctic Fossil Plants," by A. C. Seward, F.R.S.

As regards the age of the plant-bearing beds the possibilities range from the Permo-Carboniferous to the Rhaetic; the former is regarded as the more probable.

A considerable section of the paper is devoted to "General Considerations suggested by the occurrence of Glossopteris in Antarctica" (pp. 25–39). The uniformity of the Devono-Carboniferous flora throughout the world is contrasted with the appearance of more or less distinct Northern and Southern Floras in Permo-Carboniferous times. In the northern region there is no evidence of seasonal changes or of glacial conditions, while in the south glaciation was widely prevalent, and the fossil trees show annual rings in their wood. In fact, as the author points out, the Glossopteris Flora is generally associated with glacial deposits. The interesting suggestion is made that Glossopteris may have been a gregarious and deciduous plant.

The prevalence of glacial conditions in the southern hemisphere at that period adds to the difficulty of understanding how a highly organised vegetation could have flourished so near the Pole as Lat. 85°. No explanation, unfortunately, can be given; the author contents himself with the cautious statement: "That there has been a considerable change of climate is certain, but the palæobotanical data cannot be regarded as evidence favourable to an alteration in the position of the earth's axis." (p. 41).

Prof. Seward regards the Antarctic discoveries as supporting the late Dr. Blanford's view that the Glossopteris Flora may have been first differentiated on the great Antarctic continent, towards the close of the Carboniferous epoch (p. 42).

The concluding words of the memoir command our sympathy: "The heroic efforts of the Polar party were not in vain. They have laid a solid foundation; their success raises hope for the future, and will stimulate their successors to provide material for the superstructure."

D. H. S.

FUTURE COMPETITION WITH GERMANY.

THE current issue of the *Bulletin d'Encouragement pour l'Industrie nationale* (May–June, 1915, No. 3, vol. 122) is of special interest, inasmuch as it gives the views of men, each eminent in his own particular sphere, on the reasons why much of French trade has been captured by Germans; and also their suggestions for preventing the commercial aggression of the Germans after the war. The bulletin begins with a short preface by the president, M. Léon Lindet; this is followed by suggestions by M. Niclousse to the following effect: (i) A statute is to be passed for stopping foreign, and especially German, individuals, companies, or products from masquerading as French. It is urged that all machines, apparatus, and products should be of French manufacture and, if possible, invented by a Frenchman. (ii) A circular to be issued by the Syndicate of Mechanicians, Boiler-makers, and Foundrymen, urging the public to avoid purchasing anything of German or Austro-Hungarian manufacture, and to buy rather from the Allies. (iii) To prevent Frenchmen from acting as agents for the enemy. (iv) To employ no German means of transport.

Much of the French material was made in districts now occupied by Germany; it is sad to read that 95 per cent. of the steel made by the Gilchrist-Thomas process, 90 per cent. of the iron ore, 100 per cent. of steel tubes, 76·6 per cent. of rails, etc., formerly made in France, are now in German hands. On the other hand, iron alloys, cast-iron, spiegel-iron, iron coated with zinc, copper, and lead, have been little affected.

It is also hoped that duties will no longer be levied on raw materials; French manufacture has hitherto been handicapped by this.

The Syndicate of Pharmacy also suggests that French medical men be circularised, and that lists be furnished them of substances of German origin which should not be purchased. The Society of Lithographers, in its report, states that lithographic stones, previously obtained from Munich, may be replaced by plates of zinc and aluminium with advantage. Bronze leaves, and bronze, copper, and aluminium powders, it appears, have not been made in France; it is recommended that their manufacture be begun. The German success has been largely due to long credits; they sell machines, and by their banking system can afford to wait long for payment. Subsidised German transport gives German manufacturers a great advantage; it is often cheaper for a Frenchman to send his goods through Hamburg than directly from one part of France to another. A better French consular system is called for, as well as the revival of apprenticeship, and the more loyal co-operation of workmen.

Portland cement has not been troubled with German competition in France; but the machines are of German make. It appears that 80 per cent. of the cement works are in territory at present occupied by the German army.

Agricultural implements, though made to some extent in France, have largely been imported from the United States. It is suggested in this report that lending corporations, trusting for repayment to the honour of the borrowers, would be of great service, and that they would rarely have loans out to defaulters.

Such are the reports on various industries. They all reprobate German methods as unfair, while giving credit to the Germans for great industry and power of organisation.

A long article follows by Prof. Henri Hauser, of Dijon, on "German Industry as a Factor in War." He attributes to the Germans the good qualities of regular, methodical work, and a sense of, or even a genius for, organisation. "It is the union of the laboratory and the factory which has created German wealth." "It is also to be remarked that there is a close link between the director's office and the library of the economist, the geographer, and the historian." "The German chemist and the German commercial traveller walk side by side to conquer the world." These and other similar aphorisms explain the astonishingly rapid growth of German industry.

Nothing is more erroneous than to describe Germany as an over-peopled country. Of the 67 million Germans, 17 millions are tillers of the soil; but every year peasants throng into the towns; there are above 45 towns of more than 100,000 inhabitants. Cereals and meat have to be imported to feed 20 million Germans. Cotton is the largest import; its value is about 500 million marks, or 25 million pounds sterling. Germany requires much capital; new companies and ventures are continually being started; and owing to the system of credit, it may be said that she swallows capital before its birth. Companies with an imposing capital rest on the credit of industrial banks; these on Central banks; these again on the Deutsche Bank, which is guaranteed by the Reichsbank, that is, the credit of the whole German State. In order to pay for her imports, foreign trade is essential to Germany; she must sell her manufactured products. *This war is being waged to keep and to gain foreign commerce.* Konrad Hönisch, the Social-Democrat, said: "It is the social interests of the proletariat, even more than any political considerations, which render the victory of Germany imperative." The Industrial State is therefore condemned to participate in a "Welt-politik."

Prof. Hauser gives instances of "dumping"; *e.g.*, in 1900, iron wire cost in Germany 25 marks per 100 kilograms, and elsewhere 14 marks; in 1902, the Coke Syndicate forced the consumer to pay 15 marks a ton, while coke was sold abroad for 11 marks. But the gain exceeds the loss; the State-supported syndicate makes this possible. In the former instance there was a loss on foreign trade of 859,000 marks, but a gain on home trade of 1,117,000 marks.

The Germans form companies abroad, largely from foreign capital; but the majority of the directorate are Germans. For example, the *Banque des Chemins de Fer orientaux* of Zürich has a board of eight German directors, one Austrian, five Swiss, one French, and one Belgian. The ordinary shares are all held by Germans; the preference shares, with a lower rate of interest, by the foreign subscribers, for the low rate of interest does not tempt German investors. In Italy a similar state of things exists. All large concerns, such as the Nord Deutscher Lloyd, the Hamburg-Amerika line, the Deutsche Bank, the Disconto-Gesellschaft, Siemens-Schuckert, Krupp, and Guison are subventioned by the Imperial Ministry of Foreign Affairs; furthermore they are helped by *a kind of industrial espionage*, as well as by guarantees and subsidies. "Germany was 'in a blue funk' about her commerce. What would become of Essen, of Gelsenkirchen, of all Westphalia, if the Roumanians, Greeks, and Serbs were to order their cannon, rails, or locomotives from Glasgow or Creusot? War appeared preferable to

Germany than a huge commercial crash, and the iron hand replaced the velvet glove." "Little by little the idea of a necessary war—a war almost to be wished for—became the desire of the working classes; failing it, they might starve, and their employers, the capitalists, be ruined." "After the great war is over the commercial war will be on us again. We must prepare *now*."

To this essay there follow some interesting articles by M. Delloye, by M. Ernest Fourneau, director of the Laboratory of Therapeutic Chemistry at the Pasteur Institute, M. Justin Dupont, Prof. Wahl of Nancy, M. Legouëz, and M. Ribes-Christophle. Among other observations we note one stating that French manufacturers usually only keep pace with current demand for goods; when a period of prosperity sets in, he cannot supply the increased demand, and his customers are driven to buy German goods; for Germans have always reserve plant ready for an emergency. For this reason they are able to execute orders more quickly; what it takes three months to supply in France can be delivered from Germany in a fortnight. M. Fourneau gives much interesting information on German drug manufacture; he concludes: "You know that fraud and slimness pass in Germany for quasi-virtues. . . . Germany, after having tried to frighten its adversary by its terrifying appearance, knows well how to appear humble, insignificant, and invisible." M. Dupont directs attention to the enormous task before the Allies of overtaking the German colour manufacture, which has been elaborated during the past forty years. Drugs, dyes, and explosives are so interlaced that the by-products of one manufacture often serve as the raw material of the others. M. Ribes-Christophle treats of German commerce in Argentina. False labels for goods, and adulteration are common. German firms, too, supported by their banks, *i.e.*, by the Central Government, sell at first at a loss, until they have killed out competitors. Their banks, of which there are branches in Argentina, act as company-promoters.

The impression gained from these articles is that German trade is largely fraudulent, sometimes honest, always methodical; that it is regarded as the duty of the State to support it by all means, moral and immoral; and that France must take steps to exclude it if she is to retain her position as a manufacturing nation. What these steps are has not yet been indicated. We shall look forward with the utmost interest to their decision; but it should be one taken in concert with the Allies.

William Ramsay.

PROF. PAUL EHRLICH.

Only recently we lost Löffler, one of the pioneers of modern bacteriology, and now Paul Ehrlich has passed away. He died on August 20, as all good workers might wish to die—suddenly in his laboratory, in full harness, and before the rust of age had dimmed his powers.

Born in 1854 at Strehlen, in Silesia, of Jewish parents, he was one of the many distinguished Hebrews who have contributed to make Germany's fame what it is in the world of science and art. He was educated at the Gymnasium at Breslau, and afterwards at the Universities of Breslau and Strasburg, where he graduated in medicine. From the outset of his career he took the deepest interest in the chemical relationships of living matter and in the affinities of various reagents for living cells. One of his earliest researches was upon the effects of certain aniline colours upon living tissues, and he devoted much attention to staining methods, devising new stains, and Ehrlich's hæmatoxylin and Ehrlich's triacid stain are stock solutions in the present-day biological laboratory. An investigation on staining methods for the tubercle bacillus led to the discovery that certain dyes possessed a peculiar affinity for this bacillus, and this fact tinged his whole philosophy, and suggested the conception of the specific affinity of certain chemical groups for particular cells and tissues.

He carried out pioneer work in hæmatology, differentiating and classifying the various forms of leucocytes or white blood-corpuscles.

His bent now turned largely on chemical lines. Diphtheria antitoxin had been discovered by Roux and Behring, but discrepancies in its standardisation came to light, and Ehrlich set himself to elucidate the cause of these discrepancies. As an outcome of this work a method of standardisation was evolved which exists to this day, and the strength of diphtheria antitoxin is now practically always described in Ehrlich "units." This work led on to an investigation of the mode of genesis of antitoxin, and the publication of the now famed "side-chain theory" of the formation of anti-bodies in general.

Ehrlich also performed some notable researches on cancer, and developed the atreptic theory of certain forms of immunity, but this investigation was dropped before long, probably because he foresaw that it was unlikely to bear fruit.

He now returned to some of his earlier work on the specific affinity of dyes and other substances for certain cells and micro-organisms, particularly the protozoan parasites. In trypan red he found a substance which attacked certain species of trypanosomes and cured the infection caused by them, but he failed to find a substance which would cure the allied trypanosomiasis in man. Besides dyes, a large number of complex organic compounds of arsenic and mercury were prepared and tested by himself and his assistants, and resulted in the discovery of "606," or salvarsan, as a cure for syphilis.

These are some of his achievements. Not only have his discoveries already benefited mankind in the direct alleviation of human suffering, but his researches into the perplexing phenomena of immunity and chemo-therapy have opened the way for further discoveries in these directions. He must be regarded as a pioneer who has carved the first track through that dense forest of the Unknown, which the worker of the future, following in his steps, will widen into a broad highway. Ehrlich was honoured by almost every university. He was Croonian lecturer of the Royal Society, and joint recipient with Metchnikoff of the Nobel prize, and his genial and striking personality was well known to British bacteriologists. In 1897 he was created Geheimrath, and in 1911 Wirklicher Geheimrath.

In the present strife of nations, we British will be the first to recognise that in the death of Paul Ehrlich a great man, worthy to be ranked with Pasteur, Lister, and Koch in his particular line, has passed away.

FREDERICK VICTOR DICKINS, C.B.

WHEN it became known to the friends of F. V. Dickins only a few days ago that a serious surgical operation had been suddenly called for, they sadly recognised that the end was probably not far off. Heart failure and the weight of over seventy-seven years closed his life on Monday, August 16.

Dickins was a remarkable man and had enjoyed a singularly varied and interesting life. Medicine first attracted him, and after graduating (1861) M.B. and B.Sc. in the University of London, he served for five years in the Navy between China and Japan. Then he took up law, and having been called to the bar in 1870 he practised in Yokohama for many years, and at this time began to give increasing attention to those Oriental studies which occupied him to the end of his life. In 1882 he became Assistant Registrar to the University of London, the late Arthur Milman being then Registrar. It was in this capacity that he became known to the large circle of eminent men connected with the university, and especially the examiners. Soon after his appointment the practical examinations of the university were considerably amplified in scope, and examinations in practical physics were introduced for the first time. It is not too much to say that the successful conduct of these examinations at the outset was largely due to the energy of the assistant registrar, who not only obtained the necessary apparatus, but set up much of it with his own hands when required for the use of the examiners. A technical assistant for this business was employed later. He succeeded Milman as registrar in 1896.

Dickins read widely and was familiar with the chief advances in physical and natural science, in which he took great interest. But his speciality was Japanese and, to a less extent, Chinese language and literature. After retiring from the registrarship in 1901 his leisure was therefore naturally occupied with his favourite studies, and we owe to his pen the two volumes of "Primitive and Medieval Japanese Texts," published by the Clarendon Press in 1906, and the translation of the charming Japanese "Story of a Hida Craftsman" in 1912, besides other works.

Dickins was a member of the Athenæum, but owing to failing health and distance, he retired from the club two years ago.

NOTES.

THE Royal Society is compiling a register of scientific and technical men in Great Britain and Ireland, who are willing to give their services in connection with the war. The register will be classified into subjects, and will ultimately constitute a large panel of men of standing, whose services will be available whenever any Government department or similar authority requires specialist assistance. The register is being co-ordinated with those independently compiled by other societies and institutions, but the Royal Society would be glad to have applications for forms from such members of the staffs of colleges and technical institutions as have not yet been registered by any society. The Royal Society is also drawing up, with the co-operation of the principal societies and institutions, a list of scientific and technical men actually on active service in His Majesty's forces. Any names, with rank and unit, for this list will be gratefully received by the secretaries at Burlington House, Piccadilly, W.

WE learn that Mr. M. T. Dawe, formerly a member of the gardening staff of the Royal Botanic Gardens, Kew, sometime Superintendent of the Botanical and Forestry Department, Uganda, and lately Director of Agriculture, British East Africa, has been appointed Agricultural Adviser to the Government of Colombia.

THE Chilean war vessel *General Baquedano*, which has recently returned from Easter Island, has brought news of the Easter Island Expedition of Mr. and Mrs. Scoresby Routledge up to June 8, at which date the expedition had been fourteen months in residence, during which time a careful survey had been made of the existing antiquities and such ethnographical information collected as is still available.

THE Hutchinson medal for research, of the London School of Economics and Political Science, has been awarded to Mr. R. C. Mills for his thesis on "The Colonisation of Australia, 1829–1842: the Wakefield Experiment in Empire Building," and the Gladstone Memorial prize to Mr. C. M. Jones.

WE regret to hear that Capt. W. E. G. Atkinson, son of the late Prof. Atkinson, of the Staff College, Camberley, was killed at the Dardanelles on August 6. Capt. Atkinson was educated first at Clifton College and afterwards at the Wye Agricultural College, where he had a very successful career. In 1902 he left Wye and proceeded to the Rothamsted Experiment Station as a post-graduate research worker. Prior to that date there had been very few such workers at any time, and none for a number of years. Capt. Atkinson was the first of the modern contingent, which has since swelled considerably. He worked with Mr. Hall on the problem of quality in wheat. Millers and farmers alike recognised the marked differences between varieties of wheat, some—the so-called strong wheats—giving grain of high baking quality, possessing great capacity for forming large, well-piled loaves, while, others—known as weak wheats—gave rise to squat, heavy-looking loaves, much less attractive in appearance. No satisfactory chemical work, however, had been done to explain the cause of these differences; a certain number of analytical investigations had been made, but these aimed rather at discriminating between the strong and the weak wheats than at the elucidation of the cause of strength. Under Mr. Hall's guidance, Atkinson worked out the various analytical data for a series of wheats of known baking properties, and was thus able to eliminate the unsatisfactory methods, and fix attention on the better ones; in particular it was demonstrated that the percentage of nitrogen largely, but not entirely, affords a measure of strength in wheat. This information has proved valuable in subsequent studies of the problem. Capt. Atkinson then took an appointment as lecturer in agriculture at Reading, but later on went in for actual farming, a course he had always desired to follow.

Captain Arthur Kellas, R.A.M.C. (T.F.), who was killed in action at the Dardanelles on August 6, was senior assistant physician at the Royal Asylum, Aberdeen. He was a graduate of the University of Aberdeen, having taken the degrees of M.B. and Ch.B. in 1906, and that of D.P.H. in 1907. In 1914 he obtained the new diploma of psychiatry in the University of Edinburgh. His tenure of office at the Royal Asylum was a strikingly successful one; on both the therapeutic and the administrative sides he evinced gifts of no ordinary type. His work in the Physiological Laboratory of the University was characterised by qualities of a very high order, and marked him out as a man of notable promise as a scientific worker. Added to this his singular personal charm has made the sudden ending of his career to be widely and deeply deplored.

We regret to note the death, on August 20, at the age of fifty-one, of Mr. W. Hugh Spottiswoode, son of Mr. William Spottiswoode, a former president of the Royal Society. Mr. Hugh Spottiswoode was for a time a manager of the Royal Institution, to which, in 1899, he presented his late father's collection of physical apparatus; he later gave his father's mathematical MSS. to the London Mathematical Society.

The death is recorded in the *Victorian Naturalist* of Mr. F. Manson Bailey, of Brisbane, at the age of eighty-eight years. Mr. Bailey, who died on June 25, was Colonial Botanist for Queensland from 1881 until within a short time of his death.

We regret to record the death, on August 14, at the age of sixty-one years, of Capt. E. W. Owens, chief examiner of masters and mates.

A bronze bas-relief—the work of Mr. S. N. Babb—is about to be erected in St. Paul's Cathedral in memory of Captain Scott and his companions who perished in the Antarctic. At the request of the committee responsible for the memorial an inscription for the memorial has been written by Lord Curzon, which reads as follows:—"In memory of Captain Robert Falcon Scott, C.V.O., R.N., Dr. Edward Adrian Wilson, Captain Lawrence E. G. Oates, Lieut. Henry R. Bowers, and Petty Officer Edgar Evans, who died on their return journey from the South Pole in February and March, 1912. Inflexible of purpose, steadfast in courage, resolute in endurance in the face of unparalleled misfortune. Their bodies are lost in the Antarctic ice. But the memory of their deeds is an everlasting monument."

In addition to his name being expunged from the list of honorary members of the laryngological societies of Vienna and Berlin, in consequence of his having protested in a letter to the *Times* against the barbarities of Germany in the war, the name of Sir Felix Semon has been removed from the *Internationales Centralblatt für Laryngologie*, which journal he founded twenty-five years ago. We learn from the *British Medical Journal* that, in consequence of this action, all the British editorial contributors to the *Centralblatt* who have had an opportunity of seeing the declaration have withdrawn their names from and resigned their editorial connection with it. Among these are Dr. Peter McBride, Dr. H. J. Davis, Dr. Logan Turner, and Dr. Watson-Williams. They have taken this course as the only effective protest open to them against the affront to a British colleague for whom they entertain the highest respect involved in the removal of his name from an international journal founded by him. Their American collaborator, Dr. Emil Mayer, has also severed his connection with the journal as a protest against the step taken by the editor and publisher.

We notice, from the second edition of the "War List" of the Manchester Municipal School of Technology, that the following members of the staff of the school have joined H.M. Forces on active service, in addition to those named in Nature of July 15th:—Prof. A. C. Dickie, department of architecture, 2nd Lieut. Manchester University O.T.C.; F. S. Sinnatt, department of applied chemistry, Capt. Manchester University O.T.C.; F. Bowman, department of mathematics, Naval Instructor; J. L. Owen, department of applied chemistry, Lce.-Corpl. R.A.M.C. Sanitary Corps; W. W. Stainer, department of electrical engineering, 2nd Lieut. 3/4th Batt. Royal Sussex Regiment.

The twenty-sixth annual general meeting of the Institution of Mining Engineers will be held at Leeds on September 15, when the following papers will be communicated:—Some effects of earth-movement on the coal-measures of the Sheffield district (South Yorkshire and the neighbouring parts of Derbyshire and Nottinghamshire), Prof. W. G. Fearnsides; Compressed air for coal-cutters, S. Mavor; Gas-producers at collieries for obtaining power and bye-products from unsaleable fuel, M. H. Mills. During the meeting the Institution medal for the year 1914–15 will be presented to Dr. J. S. Haldane, in recognition of his investigations in connection with mine air.

The annual exhibition of the Royal Photographic Society is being held as usual (it closes on October 2) at the Suffolk Street Galleries, and although it of necessity suffers in some ways by reason of the war, special efforts in possible directions have, we think, brought the interest of the show fully up to its usual level. The contributions from America are noteworthy and various. The Mount Wilson Observatory shows photographs of vortex rings in water and in air, and compares them with hydrogen flocculi about sun-spots, and spectra of spots showing the displacement, and the tripling and quadrupling of lines due to the magnetic field. Photographs of various zodiacal lights, in which the effect of the exceedingly feeble luminosity is greatly increased, are from the University of Arizona. The various methods of discovering double stars employed at the Harvard College Observatory, and summaries of the results, are made interestingly clear by the contributions of Prof. Pickering. Dr. Nutting, of the Kodak Laboratory, sends results of lens testing, in which the figures of a luminous point yielded by lenses at various angles from the axis and different minute distances from the focus are remarkably well defined though magnified 60 diameters. An excellent series of the effects of spark discharges on photographic plates by Dr. Hoffert, results obtained with a "micro-kinetograph" apparatus by Mr. Martin-Duncan, high-power photographs of diatoms by Mr. E. A. Pinchin, and a selection of high-speed photographs by Dr. Abrahams, deserve special notice in the scientific and technical section. The natural history, colour, and other sections show no falling off in interest.

Two waterspouts were seen off Dymchurch in Kent on August 16 shortly after 1 p.m., and they are described in the *Times* of August 19 by Rev. Henry Harries. The morning had been fine, and a thunderstorm was in progress at the time. The waterspouts were of the usual kind—a long narrow funnel connected a dark cloud with the surface of the sea, at a point where the surface was violently agitated. In one case, the funnel was seen to be in rapid rotation, while downward and especially upward movements were also discernible. The waterspout at sea and the tornado on land are manifestations of great instability of the atmosphere in a vertical direction, caused either by an abnormally warm surface layer of air or an abnormally cold layer at the cloud level. The former cause is common in summer; the latter occurs both in summer and winter, and is usually associated with a "line-squall" or V-shaped barometric depression. The waterspout shows the track along which surface air passes spirally upwards to restore equilibrium. The commotion of the sea is due to the exceedingly violent character of the phenomenon. The funnel itself is probably composed partly of moisture condensed out of the air by the sudden diminution of pressure which occurs, and partly of sea-water in the form of spray. Sometimes the middle portion of the visible funnel is absent, but there must be in that case a corresponding complete funnel of rotating air from the surface to the cloud.

A USEFUL article on the war and English chemical industry is contributed to the August *Fortnightly Review* by Mr. John B. C. Kershaw A comparative analysis is given of the British and German exports of manufactured chemicals, showing that whereas the bulk of the British exports consist of heavy chemicals and "crude products," the German exports to this country, which have a value twice that of the British exports, consist mainly of fine chemicals, dyes, and pharmaceutical products. In the manufacture of the former a minimum of skilled labour and supervision is required, whilst in the German manufactures the opposite is the case. Mr. Kershaw again emphasises the fact that in Germany the directors and managers of chemical works are men whose business training has been superimposed on that obtained at a university, and who therefore have a thorough knowledge of the scientific side of the business, and realise the necessity for calling into their councils the best scientific and engineering knowledge available. One of the most important results of this is that they are not impatient of the time taken or success achieved by research work, and their knowledge of chemistry renders them less liable than inexperienced men to expect impossible results. A second factor of importance in the success of the Germans in the manufacture of fine chemicals is that resulting from the cleanliness, orderliness, and discipline of the German worker. This is attributed in no small part to the training gained during the period of military service. The article closes with a discussion of the prospects for the industry of fine chemicals and dyes in this country in the future, when the war has ended and the Germans again become active competitors.

THE arboretum at Tortworth Court is well known to be one of the finest in the British Isles. One feature of particular interest lies in the fact that the collection is entirely the work of the present Earl of Ducie, who has been planting assiduously for sixty or more years, and many rare species are here represented by the finest specimens of their kind in the kingdom. As the grounds rest on mountain limestone and Old Red Sandstone a useful choice of sites is afforded, and on the latter rhododendrons and allied plants thrive. An interesting account of the collection is given by Mr. W. J. Bean in *Kew Bulletin* No. 6, 1915, and particulars of the more notable specimens of oaks, chestnuts, maples, etc., are recorded, the latter being a remarkably fine collection. The golden chestnut, *Castanopsis chrysophylla*, from California, is one of the most famous trees, and was planted by Lord Ducie sixty years ago. The Antarctic "beech," *Nothofagus obliqua*, from southern South America, is also forming a handsome tree. The famous Tortworth sweet chestnut, with a trunk about 51 ft. in girth, is still alive, and is the tree under which King John is said to have held council; as early as Stephen's reign Evelyn says it was known as the Great Chestnut of Tortworth.

VALUABLE work is being undertaken in studying the characters of the sugar-canes cultivated at Sabour by Mr. E. J. Woodhouse, economic botanist to the Government of Bihar and Orissa, and Mr. S. K. Basu, assistant professor at the Agricultural College, and their results up to the present are published in Memoirs of the Department of Agriculture in India, vol. vii., No. 2. As in work of a similar character on other plants, the authors find that it is necessary to study varieties which have been derived from a single plant culture. Twenty-one different characters, relating to field appearance, the leaves, and the stripped canes, have been examined, and the results tabulated for a great number of individuals. The chemical characters have also been examined by Mr. C. Somers Taylor, agricultural chemist to the Government. It has been found that four definite groups can be obtained from chemical considerations that coincide with four of the groups into which the canes have been classed botanically, so that the botanical and chemical characters appear to be closely allied. Agricultural rather than minute botanical characters have been studied. The records obtained are not only of interest as being the first attempt in India to propagate sugar-cane by the method of pure-line cultures, but also because they will prove useful in studying the behaviour of these canes under different conditions of soil and climate, and will provide information in the future on the subject of deterioration.

THE Agaveæ of Guatemala form the subject of a well-illustrated paper by Dr. W. Trelease, the recognised authority on these fibre-producing plants, in the Transactions of the St. Louis Academy of Sciences, vol. xxiii., No. 3. Formerly two species of Agave and two Furcræas were ascribed to Guatemala. One of the former, however, *Agave sartorii*, is Mexican, while *Furcraea selloa* proves to be a native of Colombia. Dr. Trelease records no fewer than nineteen species of Agave and five of Furcræa from Guatemala, all except the two previously recorded being new, and described and figured for the first time in the paper. A fact of some geographical interest is that the spicate subgenus of Agave, Littæa, does not appear to reach into Central America any more than it does into the West Indies. The species which have been collected mainly by Dr. Trelease are based almost entirely on leaf characters, but these are always found to afford satisfactory distinguishing features in this genus. The habit of the various species and their leaf characters are well shown in the thirty excellent plates.

A USEFUL article on the European pines, their commercial importance and their relationship to British forestry, is published in *Kew Bulletin* No. 6, 1915. Ten species of Pinus are discussed, *P. canariensis* being included. *P. laricio*, *P. pinaster*, and *P. sylvestris* are the species of most value for planting in Great Britain. Under the maritime pine (*P. pinaster*) an account is given from the Consular Report of the remarkable success which has attended the planting of this species in the Landes of south-western France, and of the value both of the turpentine and the timber.

THE remarkable parasitic genus Phelipea (Orobanchaceæ), containing three species all with brilliant scarlet flowers, is described and figured in *Kew Bulletin* No. 6 by Dr. Stapf. *P. foliata*, the species figured, flowered at Kew both in 1914 and this year, and formed a striking object with its large flowers springing from among the silvery leaves of its host plant, *Centaurea dealbata*. The history of the genus Phelipea is somewhat involved, and the synonymy, which is in consequence very complicated, has been satisfactorily elucidated in the present paper. Dr. Stapf describes a new species, *P. boissieri*, distinguished especially by its bifid calyx and bearded anthers. The genus is a native of Asia Minor, the Caucasus, and northern Syria.

THE July number of the *Scottish Naturalist* is entirely devoted to the report, by Miss Evelyn Baxter and Miss Leonora Rintoul, "On Scottish Ornithology in 1914," but the interest of its contents will appeal to a wide circle of readers, and especially those concerned with the problems of migration. During the last few years, Fair Isle, lying midway between the Orkney and Shetland Islands, has become an observation station of the first importance, not only because many additions to the list of our British birds have been made from records obtained from this small area, but also because of the facilities it affords, from its small and isolated area, for the analysis of the components of passing streams of migrants. The most important addition to the Scottish avifauna during 1914 was that of the Aquatic Warbler (*Acrocephalus aquaticus*), which was obtained on Fair Isle on October 23rd. In their summary of migratory movements, the authors record "an enormous immigration of woodcock to Fair Isle" on March 26, followed on March 30 by a further influx. While all will feel grateful to the compilers of this most admirable report, many will regret the assumed necessity for adopting the most up-to-date vagaries in nomenclature, especially such as *Coccothraustes coccothraustes coccothraustes*!

IN the Annals of Tropical Medicine and Parasitology for July (vol. ix., No. 3), Messrs. Warrington Yorke and B. Blacklock deal with the bionomics of the tsetse-fly, *Glossina palpalis*, which conveys human trypanosomiasis and sleeping sickness, and with the reservoir of the human trypanosome, in Sierra Leone, and Dr. Fantham gives an account of a spirilliform micro-organism, *Spirochaeta bronchialis*, which produces bronchial affections in the Sudan and other parts of the world. It is distinct from the spirochaetes which are of frequent occurrence in the mouth. The articles are illustrated with numerous plates.

WE have received the *Review of Applied Entomology*, series B, Medical and Veterinary, for July (vol. iii., series B, part 7). It contains a valuable summary of the current literature dealing with the part played by "insects" in the propagation of diseases in man and animals, such as plague, malaria, sleeping sickness, and Texas fever.

A SUMMARY of rainfall, mean temperature, and sunshine for the second quarter, April, May, and June, 1915, has been published as an appendix to the Weekly Weather Report by the Meteorological Office. Comparison is made with the thirty years' average, 1881 to 1910, and the values are given for the several lustra during this period as well as for the individual years from 1911. The quarter was dry and sunny, with normal temperature. For the current year the rainfall was 77 per cent. of the average over the eastern districts of the British Isles, the percentage ranging from 59 in the north-east of England to 102 in the south-east of England. Over the western districts, including Ireland, the rainfall for the quarter was 75 per cent. of the average, the percentage ranging from 69 in the north of Ireland to 88 in South Wales and the south-west of England. The mean temperature was 1° above the average in the south of Ireland, whilst in all other districts the departure from the average, plus or minus, did not amount to 0·5°. The duration of bright sunshine over the eastern districts was 109 per cent. of the average, whilst in the western districts it was 105 per cent. The only districts with a deficiency of sunshine were the south-west of England, the south of Ireland, and the English Channel; in the latter district the duration was only 82 per cent. of the average.

THE rainfall table for July in *Symons's Meteorological Magazine* shows the month to have been very wet in nearly all parts of the British Isles. The data are only for a few stations in comparison with those which will be given later by the British Rainfall Organisation. At Mickleover Manor in Derbyshire the fall was 250 per cent. of the average, the actual excess of rain being 3·84 in. At Hull the rain was 240 per cent. of the average, and at Geldeston it was 233 per cent. The only stations in the table with a deficiency are Newcastle, Aberystwyth, and Wick. In the Thames Valley, where the rainfall is graphically shown by the usual monthly map, the measurement exceeded 5 in. over a fairly large area. Over the British Isles the rainfall was 148 per cent. of the average, the fall in the different parts of the kingdom being, England and Wales, 155; Scotland, 125; and Ireland, 158 per cent.

La Nature (July 31) contains a highly interesting article on the manufacture of shells, the various processes being illustrated with excellent diagrams and photographs. The author points out that the war has already radically changed our conceptions on many points; that no longer does success depend so much on the number of combatants as formerly, and that victory is more assured to that adversary which is capable of expending most shells in the least space of time, and it is therefore towards the factories that all considerations converge. Reference is made to the return to the factory of munition workers from the front, there having been a steady exodus in this direction in France since the first months of the war, but necessarily the reorganisation of the factories has had to precede the recall of the workmen. After a lucid description of the various processes through which the shells for the celebrated 75 mm. gun pass, the question of inspection is detailed. Out of every thousand, twenty are examined; if one is defective another twenty are selected, and if another fails the whole batch is examined one by one. Finally, twelve are taken and tested on the firing ground, being afterwards examined for any deformation they have undergone.

Engineering for August 13 has an article on the Port of London Docks and traffic. Important work is being done for the extension of the Royal Albert Dock southwards. The plans of the new work have been altered. The dry dock is now to be made 750 ft. long, and the main dock is to be increased in depth from 35 to 38 ft. The entrance-lock, 800 ft. long by 100 ft. wide by 45 ft. depth below Trinity high water, is making very good progress; the wall on the north side is completed, and 650 ft. of the south wall is built almost to coping level. The main basin is to have an area of 65 acres, and more than two-thirds of the excavations have been made. The south quay has been practically finished, and 670 ft. of the north quay is nearing completion. The trench excavations for the north wall of the dry dock have been made for a length of 580 ft., and a length of 230 ft. of concrete walling is in progress. The passage connecting the new and the old docks is progressing. The lock-gates, caisson, and bascule and swing-bridges are being constructed by Sir William Arrol and Co., Ltd., of Glasgow.

ALTHOUGH amongst the ordinary chemical elements potassium and rubidium are the only ones which have shown a measurable amount of radio-activity, it has not yet been proved conclusively that the small amount of β-radiation observed in the case of these substances has not been due to radio-active impurities. The most satisfactory proof of the radio-activity of these elements would be to trace their radio-active products. According to the laws that expulsion of an α-particle decreases the atomic weight by 2, and removes the product two places to the left in the periodic table of elements, while expulsion of a β-particle, while producing no appreciable change in the atomic weight, moves the product one place to the right, potassium should produce an element with the chemical properties of calcium, but with atomic weight 39·15, and rubidium an element like strontium, but with atomic weight 85·45. An investigation directed towards the detection of these new elements has been proceeding for some time at the radiological laboratory of the Scientific Society of Warsaw under Dr. H. Lachs, and a preliminary communication on the subject was made to the society at the meeting on March 4, but no definite conclusion had at that date been reached.

AN interesting new method of standardising normal and decinormal solutions of acid used in volumetric analysis is described by Mr. Francis D. Dodge in the *Journal of Industrial and Engineering Chemistry* (vol. vii., No. 1). The article is reprinted in the *Chemical News* (August 6). Use is made of potassium hydrogen phthalate, which is easily prepared in a pure state by dissolving phthalic anhydride in aqueous potassium hydroxide and recrystallising the product. The salt, when dried at 110°, is anhydrous, $C_8H_4O_4.HK$, and behaves like a monobasic acid, the end-point in the titration being remarkably sharp.

OUR ASTRONOMICAL COLUMN.

THE AUGUST PERSEIDS.—One result of the recent observations of this shower will be the determination of a large number of real paths of meteors not belonging to the Perseid swarm. The minor radiants visible between August 10–20 were very numerous and interesting. In several cases, however, the meteors doubly observed do not work out very well, and these await further investigation. Some of the other observers have not yet sent in their results.

A splendid meteor was seen over the southern region of Scotland on August 13 at 9h. 16m. It was fortunately recorded by Mr. A. King from near Edinburgh, and Mrs. F. Wilson saw the object near the N. by W. horizon, though her station at Harrow-on-the-Hill was distant about 370 miles from the place of the meteor.

The following are the particulars of fifteen non-Perseids seen during this year's display and computed by Mr. Denning:—

Night	G.M.T.	mags.	Height at first	Height at end	Path length	Velocity per sec.	Radiant point	Meteor's name
	h. m.		m.	m.	m.	m.	° °	
Aug. 10	9 33	1 > 1	68	52	154	38	40+29	Muscid
	10 23½	2½ - 2	84	45	52	20	290+11	ε Sagittid
	11 0½	3 - 2	81	55	63	42	40+38	β Perseid
Aug. 12	10 18	2½ - 2	74	42	32	16	281+43	α Lyrid
	10 18	♃ - ♃	80	55	67	—	46+44	α Perseid
	10 44½	2 - 2	56	58	192	35	39+7	α Cetid
	11 28	2 - 1	77	54	32	40	315+13	Delphinid
Aug. 13	9 16	♀ > ♀	52	43	19	19	280 - 13	δ Antinoid
	10 40	4 - 2	69	46	28	56	300+20	η Sagittid
	10 40½	2 - 2	68	51	27	36	332+10	ε Pegasid
	11 11	5 - 2	77	50	44	28	343+14	α Pegasid
Aug. 14	10 14	4 - 4	67	52	24	25	194+64	ε Ursid
	10 25	1 > 1	49	41	82	16	153+41	μ Ursid
	10 36½	2 - 1	67	61	7	11	302+13	α Aquilid
Aug. 18	10 40	3 - 2	59	52	29	58	72+41	η Aurigid
Aug. 19	9 20	> 1	79	57	65	44	135+59	υ Ursid

THE TUBE ARC SPECTRUM OF IRON.—The installation of a 100-kw. transformer in the Pasadena laboratory has enabled Dr. Arthur S. King to extend his investigation of the spectrum peculiarities of the tube arc, and he has now carried out a comparison of typical iron lines in tube-arc and spark spectra. In these later experiments, according to a paper in the *Astrophysical Journal* for June, the best results are stated to have been obtained when energy was being supplied at the rate of 40 kw. at the moment of rupture of tube (*i.e.* formation of tube arc), the exposure being made whilst the current fell from 1000 to about 600 amps.; the second order of a 4-inch plane grating was used in the vertical telescope with an objective of 30 ft. f.l., the dispersion being 0·9 A. per mm.

The tube arc is found to resemble the disruptive spark in imparting unsymmetrical structure to many of the stronger lines, the magnitude of the effect being closely related to their furnace and pressure classification. The least affected lines are the flame lines. In the spark, very curiously, the enhanced lines remain symmetrical. The conclusion is reached that strong electrical excitation, together with high vapour density, produce displacements resembling the effect of pressure, and the suggestion is advanced that the *density of high-speed electrons* is the operative common factor.

A brief account of the same investigation forms No. 9 in the series of Communications from the Mount Wilson Solar Observatory to the National Academy of Sciences (U.S.A.) Proceedings, vol. i., p. 371, June, 1915.

CONTROL OF AUSTRALIAN OBSERVATORIES.—From an Australian daily contemporary we learn that the Public Service Commissioner has recommended the transference of the Victoria Observatory to the Federal Government on the grounds that it is a *national*, and not a *State*, institution. It is added that there is a consensus of opinion among the astronomers of the various States that it would be well to hand observatories over to Federal control.

PROPER MOTIONS OF THE STARS BY STEREOSCOPE.—M. J. Comas Solà (*Comptes rendus,* vol. clxi., p. 121, August 9, 1915) describes an interesting attempt to employ the stereoscope in the study of stellar motions. By means of a camera, aperture 160 mm., f.l. 800 mm., mounted on a 6-in. equatorial as finder, photographs of the globular cluster M. 11 (Aquila et Antinous) were taken on July 12, 1912, and again on July 20, 1915. The negatives were then viewed in an ordinary stereoscope with striking results. On a surface 20 degrees square, no fewer than 200 stars exhibited sensible proper motion, and it proved specially easy to pick out groups of stars having common or related proper motions. It is suggested that it should not be difficult to obtain quantitative results in employing a stereocomparator or stereometer. The preliminary qualitative survey indicates that the greater part of the stellar trajectories in the region studied make a large angle with the mean line of the Milky Way.

SOLAR VORTICES. Having established beyond doubt the existence of the Zeeman effect due to the magnetic field in sun-spots, Prof. George E. Hale has now been able to trace the law of rotation in spot vortices by some highly significant observations communicated to the National Academy of Sciences, U.S.A. (Proc., vol. i., p. 382). The typical sun-spot group consists of two spots of opposite magnetic polarity, and thus rotating oppositely, lying almost parallel to the solar equator. The preceding spot is usually the dominant member, whilst the following spot may consist of small spots or be represented merely by flocculi, the characteristic feature of the group being the presence of magnetic fields of opposite polarity in the regions of its eastern and western extremities. Briefly, the present results indicate that the direction of rotation depends on the phase of the spot cycle, thus in *low latitudes* (end of cycle) the rotation in the spot vortex (preceding spot) is the same as in a terrestrial tornado, *i.e. anti-clockwise* in the N. hemisphere, but in *high latitudes* (beginning of cycle) the direction of rotation is the reverse; each spot belt is thus divided into two zones of approximate mean latitudes of 9° and 23° respectively.

In collaboration with Mr. George P. Luckey, Prof. Hale has been conducting some novel laboratory experiments (Proc. Nat. Acad. Sci., vol. i., p. 385) in vortex motion; means have been successfully devised for reproducing the characteristic features, not only of spot vortices, but also to some extent the movements in flocculi.

LIFE-HABITS OF THE OKAPI.

DR. CUTHBERT CHRISTY, known to a good many people by his medical research work and botanical collecting in West and in Central Africa, recently spent several years in the service of the Belgian Congo, and was directed, amongst other things, to give careful study to the okapi in the forests of north-east Congoland. The result is that we have for the first time an accurate and detailed description of the life habits of the okapi. Dr. Christy has also, I believe, been the first to bring to Europe the "soft parts" of this Giraffid. A few years ago this was what many zoologists were longing for; the soft parts (intestines, genital organs, etc.) of the okapi were needed to supplement the study of its skeleton and enable us to fix with precision its position in the giraffe family, and perhaps the basal relations of that group with other Pecora.

Unfortunately, Dr. Christy arrived home (after running many war risks on the way) with his valuable cargo of specimens at a time when we were so completely engrossed by the war that little interest was aroused, and little attention was given to his remarkable researches. The comparative anatomists who might have examined his material are apparently absent from their usual seats of learning engaged in war business. I understand that Dr. Christy has placed the soft parts of his specimens in the British Museum (Natural History), and we may hope perhaps that they will there receive examination at competent hands.

Dr. Christy adds his testimony to that of his predecessors in the same quest as to the "invisibility" of the okapi, whose markings and coloration—*pace* Colonel Theodore Roosevelt—so break up the surface of its large body and long legs as to cause it to fuse with the dark-brown, russet, white and yellow-white of the twigs and stems and leaf-stalks amongst which it moves. He also points out that the hoofs of the okapi are so closely pressed together that the footprint is almost like that of the single-toed donkey. On the other hand, he does not believe that the okapi feeds on the big leaves of the Sarophrynium (an amarantaceous plant), it merely resorts for concealment to these 6-ft. high thickets. Nor does it necessarily feed at night only, but rather in the early morning and late afternoon. It feeds chiefly on the small leaves and twigs of trees, which it "hooks down with its long, mobile tongue." It does not eat grass, but does browse on the coarse herbage on the outskirts of the forest. These notes are extracted from an extremely interesting article in the *Field* of July 10, which contributes likewise a good deal to our knowledge of the Bambute pigmies, almost the only foes the okapi has.

In connection with this subject might I again put forward the suggestion that the very puzzling remains of so-called "antelopes" recently found, not only in southern California, but actually in Maryland (eastern North America), may be the bones and teeth of primitive Giraffids and not of "elands" or Tragelaphs, as surmised by American zoologists. The nearest relation of the isolated giraffe group at the present day would seem to be the pronghorn of western North America. It is quite conceivable that the Giraffids may have arisen from the indeterminate Antilocaprid group (intermediate between the Deer and the Bovids) in North America, and thence have spread to north-eastern Asia and eventually to India, Persia, Africa, and southern Europe. There are giraffine remains found fossil in China, and north-west India would seem to have been the area of greatest variation and specialisation.

H. H. JOHNSTON.

THE SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

PRETORIA MEETING.

EXCLUDING the purely formal meeting of 1905, in which year we joined forces with the visiting British Association for the Advancement of Science, this is the second session of the association to meet in the Transvaal and the first to meet in Pretoria. Our association was started in 1903 at Capetown, and in 1904 the meeting was held in Johannesburg, but on that occasion one day was spent in Pretoria. This year we hold our meeting in what is now the administrative capital of the Union, but we are invited to spend one day in Johannesburg, visiting the Crown Mines, when visitors will have a favourable opportunity of seeing the conditions under which our staple industry is conducted, especially with regard to modern views on hygiene and the preservation of life.

The calm atmosphere of our association is especially suitable for discussions upon the broad principles underlying polity. In the present times these principles are being profoundly modified; old standards of government seem to be weakening day by day, and our association affords a common ground where tendencies can be examined for what they are worth, instead of through the distorting lenses of party passion.

[1] Abridged from the address of the president, Robert Thorburn Ayton Innes.

War and Science.

We meet this year under extraordinary circumstances, during a period of war unequalled in the history of mankind in its extent and intensity. A superficial view would be that our association has nothing to do with wars at any time, and should ignore the present war. This view would be entirely wrong. The war touches humanity at every point, in every interest. I am therefore going to deal with it, but in such a way that no one could say to which side my sympathies lean. I have, like everyone else, very decided views upon the rights and wrongs of the war, but these concern one of the aspects with which we as a scientific body have nothing to do.

A certain school of thought—not particular to any one nation—has praised the value of war as a discipline, and even as a moral force. Another school looks upon war as a curse for which no defence is possible. Science is impersonal, and looks merely to facts. Yet science cannot but feel degraded when it finds so great a part of its recent advances applied so freely and almost solely as aids to the destruction of human life. The pre-eminent inventions of our present generation—wireless telegraphy, the airship, the flying machine, the submarine, thermite, and other allied heat producers—seem to have found their culmination in use in war. How different is this from the ideal of the man of science—the most altruistic possible—the lightening of the burdens of humanity by the mastery of natural forces—the transformation of inanimate power to relieve mankind from arduous work—the conquest of pain and disease—the improvement of agriculture—and, by no means least, the enlargement of the human mind. Greek culture—that extraordinary efflorescence of a limited community of small cities, which we prize so highly to-day, and whose lesson seems to be valid for all time—we are told was only possible because the Greek civilisation was built upon slavery; the helot was the pivot on which it turned. The man of science looks forward to a period of leisure and culture equally founded upon a slavery, but not upon the unwilling slavery either of man or beast, but upon the willing slavery of machinery and of the powers of nature harnessed for use.

An increasing and unfaltering search for truth, with a belief in the betterment of humanity through knowledge, is the ethical basis of science, and none other. If science could only serve material ends—the increase of money—profit, or serve to rivet the domination of one State over another—then it would be worthless; nay, it would be unclean.

We perceive to-day that when any one nation deliberately uses the resources of science as an aid to war, a burden of terrible import is thrown upon other nations. And herein is another apparent great evil of science, because its advance makes war both more terrible and more destructive. I say an apparent evil, because if it is not controlled it will lead to exhaustion, and so limitation will have to come by necessity. I believe that in earlier ages the individual, or at least the family, the patriarchal group, was to a great extent, like a nation is now, each a law unto itself, and it was only as weapons got more expensive and deadly that the small group was willing to abandon the right of private revenge or redress. In yet later ages the baron in his great castle could defy the king, but the invention of the cannon and the control of the manufacture of gunpowder by the king made even the most powerful barons willing to accept the king's peace. To-day we would not tolerate any man or group of men turning their buildings into fortresses; to-morrow, I hope, I believe, that nations, or a federation of nations, will likewise refuse to allow any other nation or group of nations to arm themselves to such an extent that it or they can become a menace to the peace of the rest of the world.

Organisation.

There is another and more positive lesson for us in the present war. It shows the power of organisation. We see two Empires, but roughly one—the Germanic nation—at war with four other great nations, which has so developed its resources and organised them, that it can stand the strain of such a war that 25,000,000 picked men have already been in the field. However deplorable this may be from ethical and economic points of view, it at least does show what science and organisation can do to-day. I suppose that, one way and another, 50,000,000 of the human race are either fighting or supplying food and munitions of war to the combatants. And no sign of exhaustion is as yet clearly discernible. When we remember that war in the olden days was conducted with small armies and only during a portion of the year, we realise the maleficent power that science has placed in the hands of mankind. It needs careful regulation. This power for evil might only have been potential, it might have remained undeveloped; but we have found to our loss that at least one nation has developed and organised itself, by the aid of science, to such an extent that it dares to declare itself independent not only of the power, but even of the opinions of the rest of the world.

The lesson will not be lost. If the deliberate organisation of a single nation can result in such power, then every nation must organise. Not necessarily organise for war, for death; but organise for peace, for life.

Laissez faire passed into twilight when the great war commenced. We have to turn our eyes in the direction of the rising sun of an organised humanity, of which we perceive the dawn already. Then the advancement of science will surely have no sinister meaning. We pray that the advancement of science will be identical with the advancement of humanity.

Progress of Astronomy.

I am perhaps fortunate in belonging to a branch of science which has nothing to do with war. Therefore the astronomer can regard war with a sense of detachment; and to those who know the stars, the immensity, the eternity of the universe, its increasing grandeur, war seems trivial and foolish—the work of unbalanced minds.

I spoke of one of the aims of science as the enlargement of the human mind. Although every branch of knowledge—a word which I take to be nearly synonymous with science (science being co-ordinated knowledge)—leads to the extension of the human mind, to-day astronomy has no other real use. We know that clocks are corrected through the observations of the stars, and that the sun and stars must be observed by navigators, but preparation for these practical applications forms a very trifling portion of the activities of astronomers. The very perfection of that part of astronomy reduces it to a sort of automatism—it all but goes by itself. To-day the astronomer wants to find out the dimensions of the sidereal system—the extent of the universe—the structure and arrangement of the stars in space—their relations to each other—the interpretation of their spectra—the dynamics of the universe—the cause of variable stars. The solutions of any or all of these questions can scarcely have any material effect upon mankind—the effect is spiritual and emotional—man is proud to find that he can plumb space to its uttermost depth; he presumes that the germ of the future which was conceived in the past is taking its form to-day, and that the process is continuous, and that as to-day he can predict tides and eclipses, so with greater knowledge he will in the future be able to predict the course of the sun amongst the stars and the future conditions of the planet upon which he has his being.

The Distances of the Stars.

The problem which will be more closely discussed in this address is that of the distance of the stars. The most direct way of finding these is by the parallactic displacement of the stars caused by the motion of the earth round the sun. In this inquiry the Union can have a local pride, as the first parallax[2] certainly found was that of α Centaurus by Henderson, the Cape Astronomer. The late Sir David Gill, our first president, continued Henderson's work, and perhaps one might say finished it in that form. Gill was an organiser, and when the parallax campaign, initiated by himself and completed with the aid of Dr. Elkin and others, had come to an end, it was apparent that the most direct[3] method of finding parallaxes which was available would only yield a small crop, because the stars are at such enormous distances from the sun that the available base-line for measurement, the diameter of the earth's orbit, some 186,000,000 miles, or 300,000,000 kilometres, is vanishingly small at the distance of all but a few near stars. α Centaurus is the nearest known, and almost certainly the nearest to the sun, yet at its distance the diameter of the earth's orbit subtends an angle of but $1\frac{1}{2}$ seconds of arc—an angle which is described by the minute hand of a clock in a four-thousandth part of a second of time. An angle so small is difficult to observe directly with accuracy, so that at best the measures must become differential—that is, the stars are measured from neighbouring stars supposed to be at a much greater distance away; such stars are called comparison stars.

Prof. Eddington estimates that there are thirty stars with a parallax of 0·20″ or greater, of which nineteen are already known. This means that within a distance nearly four times as great as that of α Centaurus there are but thirty stars in all. This is the limit of visual work such as was done by Gill, but photographic methods, especially with the enormous telescopes used in America, carry the direct attack further.

The delicacy, or, if you prefer, the accuracy, of any measurement is limited by its probable error. The probable error of a parallax measured visually under good circumstances (such as with the Cape heliometer) is about 0·10″ (a tenth of a second of arc), and this is already, small as it is, a quantity larger than the quantity to be measured except in the cases of a hundred or so stars. The same method of parallactic displacement of stars on photographic plates has a much smaller probable error. The most recent determinations made with the great telescopes of America, and in particular the 40-in. refractor of the Yerkes Observatory, have a probable error of about 0·01″, or ten times less than the usual visual method, and Dr. Van Maanen, using photographs taken with the 60-in. reflector of the Mount Wilson Observatory, has reduced this probable error to 0·006″, or about a hundred and seventieth part of a second of arc. As regards the measurements of small quantities, this is a wonderful achievement, but delicate as these measure-

2 But not the first announced. Bessel in 1838 announced the measurement of the parallax of 61 Cygnus two months earlier than Henderson, whose delay was caused by his removal to Europe.

3 The only direct parallax found was that of α Centaurus, by Henderson. All other parallaxes of any certainty depend on an indirect method involving the assumption, nearly true, that all the stars with a few exceptions have very minute parallaxes.

ments are, they are too coarse to tell us much about the distances of the stars.

Let us consider several recent sets of parallax measures :—

(1) Van Maanen's list of five stars is as follows :—

Star		Parallax		Probable error
96	...	0·026″	...	+0·007″
672	...	−0·009	...	0·004
1549	...	0·001	...	0·002
2921	...	0·078	...	0·006
3233	...	0·003	...	0·010

(2) In two recent lists we find parallaxes for 61 Cygnus, the star for which Bessel first found a parallax.

Authority	Parallax	Probable error
Miller, 24-in. telescope, Sproul Observatory	0·301″	+0·010″
Slocum and Mitchell, 40-in. telescope, Yerkes Observatory ...	0·272	0·005

The negative parallax in Van Maanen's list would mean that the star was actually more distant than its comparison stars, which is at least unlikely, and in two other cases it will be seen that the parallaxes found are smaller than their probable errors. Somewhat similarly, in the case of 61 Cygnus, although the two parallaxes found agree very well, they differ by much more than their probable errors.

(3) In the recent most considerable list of stellar parallaxes published (Slocum and Mitchell, *Popular Astronomy*, March, 1914), out of twenty-eight results, eight are negative parallaxes and another four are smaller than their probable errors; yet the list is one of stars selected for large proper motion or some other peculiarity which indicated a measurable parallax.

These three sets show us that, valuable as the photographic method is, it is to be feared that it will also soon work out its rich lodes. So it does not take us much further. In this way the direct attack by parallactic displacement will reveal perhaps some one or two hundred parallaxes; but we would learn nothing as to the distances of the great mass of stars, except what we already know, namely, that the distances are tremendous.

Fortunately there is an indirect method of attack which, in the course of time, will tell us the distances of all the stars.

Basically this method depends upon a knowledge of the proper motions of the stars. If by its annual motion around the sun, the earth causes the stars to be displaced, it is obvious that the progressive motion of the sun through space must cause a progressive displacement. If for the moment we assume the stars to be at rest, they will seem to suffer two displacements—one purely periodic in a year, the other progressive, due respectively to the earth's orbital motion and the sun's motion through space.

The earth's orbital motion being periodic has no cumulative effect, but the sun's progressive motion is cumulative. The amplitude of the earth's periodic motion is about 300,000,000 kilometres, and all the best and most recent results show that the sun is moving through space with a velocity of about 18 kilometres a second; hence in a year the sun, and with it, of course, the earth and the rest of the solar system, move over a distance of 550,000,000 kilometres; roughly this is already twice the earth's annual displacement, and, as already stated, it is cumulative; thus, in six years, the progressive displacement is already eleven times the earth's periodical displacement, and the gain is continuous. Hence the mere lapse of time will tell us the distance of the stars, but the problem is complicated because the proper motions of the stars are not mere reflexes of the sun's proper motion; the stars themselves are also in motion, so that a process of unravelling is necessary. Without any unravelling, but by simple averaging, the elder Herschel found that the sun was travelling in the direction of the constellation Hercules. At Capetown, in 1905, Prof. Kapteyn announced his discovery that the proper motions of the stars divided themselves into two distinct drifts. The elder Boss found that the proper motions of a widely-spread group of stars converged to a point. The same astronomer also found, from a study of the proper motions, that there was a marked relation between the amount of proper motion and a star's spectrum.

Investigations based upon proper motions—the thwart or across the line of sight motions—were powerfully aided by spectroscopic results, and especially by the application of the Doppler principle, which tells us almost directly the radial velocity of the star, or its motion in the line of sight. The interpretation of stellar spectra is far from complete, and its problems will not be discussed to-night. The broad facts are that stellar spectra, with a few exceptions, fall into four great classes, which may be called the helium stars, the hydrogen stars, the metallic stars, and the carbon stars, in which the gradation from one class to another is so well marked that it is very plausibly assumed that a star of one class can in the course of time change into its contiguous class, and from that into its next class. At present it is assumed that the helium class is degrading or cooling into the hydrogen class, and that the hydrogen class is similarly approaching the metallic class (in which our sun is), and that later the metallic class will degrade into the carbon class, and that, finally, the carbon class will cool down and become dark stars. This continuous degradation is a convenient *memoria technica*, but it is not based upon any facts. Sir Norman Lockyer, by a closer study of spectra, asserts that there is both a descending and an ascending scale. The assumption that there are the dark stars above referred to is unsupported by any fact. But to-night we are only concerned with spectrum analysis as an aid to interpreting the proper motions of the stars. Radial velocities fully confirm the motion of the sun through space as disclosed by the proper motions. The recent spectroscopic determinations of the direction and amount of the solar motion made by Dr. Campbell in America and by Messrs. Hough and Halm at the Cape, agree within a reasonable margin with the determinations of Newcomb and Boss, which are based on proper motions. Further, as with the proper motions, it is found that as the stars degrade from helium to hydrogen to metallic to carbon spectra, their velocities increase. Prof. E. C. Pickering and others have shown how certain species of stars aggregate in certain parts of the sky. Thus the helium stars are only found near the Milky Way, that great girdle of stars which is the framework of the sidereal system. The direct measurement of parallaxes, and the smallness of their proper motions, both indicate that the helium stars are enormously distant; and conversely, that stars near us are generally of the metallic spectrum class. Besides the Taurus group of converging stars found by Boss, several other groups, with members spread all over the sky, have been found. The stars in these groups appear to be moving with nearly equal and parallel velocities through space. It is evident that once a star is grouped correctly, and the parallax or distance and velocity of any one star in its group is known, we can also determine its distance. Unfortunately the Doppler principle, by which astronomers determine the radial velocities of the stars, is somewhat limited in its application. In the helium and hydrogen classes the lines of the spectrum are few and are difficult to measure, and in all classes it is only possible to measure the displacements of the lines of the bright stars. Even if we anticipate improvements in the art of spectrography, it would seem impossible to obtain spectroscopic data in the form required for more than twenty or thirty thousand of the brighter stars. Therefore, although spectroscopy will be a useful ally, its help is limited.

Let us now collect the data which are at the astronomer's disposal for finding the distance of the more distant stars. The most important datum is the star's proper motion. This is compounded of the reflex of the sun's motion and of the star's own proper motion, which latter may be eliminated by a process of judgment by assuming that the star is an average member of its group and spectral class, or that it belongs to one or other of Kapteyn's two drifts. Although in individual cases these indications may be very erroneous, yet in the gross they are permitting astronomers to classify the stars into manageable groups.

What is wanted is a better knowledge of the proper motions of the stars. Unfortunately at present these are not well known except for perhaps 10,000 of the brighter stars. Hitherto, the finding of the proper motions of the stars has been slow, arduous, and expensive work. At least ten meridian observations, spread over half a century, were essential, and each meridian observation cost about 20s., and meridian observations can only be made of the brighter stars—of perhaps 100,000 out of 1,000,000,000 stars now within the reach of the largest telescopes, or of one star in every 10,000. This proportion is altogether too one-sided. Hence astronomers hailed the advent of the photographic dry plate. An organisation for a *Carte du Ciel* was formed, in which our first president, the late Sir David Gill, was one of the chief promoters, and this scheme has now been at work for twenty-eight years; but, so far, the first *Carte* is far from complete. When completed in ten or twenty years' time, we may expect it to furnish us with precise positions of some 3,000,000 stars (or of about 1 star in 300, still a very small proportion). We will not know the proper motions of these stars. To achieve that, another *Carte du Ciel* must be prepared, so that we must expect another half-century to elapse before we are in possession of these 3,000,000 proper motions. Again, the labour, and with it the cost, involved is enormous, and will probably be in the neighbourhood of 10s. a star.

The drawback to these two methods of obtaining proper motions is the necessity for defining the exact position of each star at different epochs, whilst what we want is not its exact position, which is difficult to define, but its change of position—that is, its proper motion. At the beginning of this century it had been suggested that there was no necessity to measure the places of all the stars on photographic plates, but that if pairs of plates were examined in the stereoscope, those stars which had moved relatively would stand out in relief; alternatively, that if pairs of plates were superimposed, those stars which had moved by proper motion would easily be picked out. These suggestions were tried, and led to the discovery of a few proper motions, but the method was not workable on a large scale, mainly because of fatigue or strain upon the eyes. A third alternative was discovered by Dr. Pulfrich, of Jena, and described by him as a blink method. By this method the pair of plates to be examined is placed side by side, like the pictures in a stereoscope, but they are examined with one eye through an optical and mechanical arrangement which rapidly lets the eye rest first on one plate and then on the other, so that in one second the eye has looked at each plate separately three or four times. This blinking makes the eye wonderfully sensitive to the slightest shift upon the plates. If one star relatively to its neighbours has shifted a hundredth of a millimetre upon a *Carte du Ciel* plate, the change is not only unmistakable, it is obtrusive. This blink-method revolutionises astronomy of position as regards the stars. Both with the meridian observations and the *Carte du Ciel* measurements, each star had to be dealt with separately. In the blink method the stars are dealt with in groups. Indeed, one can say that it is easier to deal with 1000 stars by the blink method than with one by the other methods. All that the blink method requires is pairs of plates separated by as long intervals as possible. A few weeks ago Mr. Hough (H.M. Astronomer at the Cape) placed in Mr. Voute's and my hands a pair of plates with a time interval of nearly twenty-three years. There were about 10,000 stars on the two plates; in a few hours we were able to announce that only twenty of these showed proper motion—the rest were fixed stars—and we were able to find the proper motions of many stars which were so faint that even the great *Carte du Ciel* would not have included them. Since then further pairs of Cape plates have been placed at my disposal with intervals of sixteen to eighteen years; the results confirm the earlier experience. We can therefore clearly state that astronomers have now a weapon of attack which will in the course of time reveal to them, without arduous or expensive labour, the proper motions of all classes of stars from the brightest to the faintest. This will lead to a knowledge of the structure of the sidereal universe which a few years ago seemed unattainable. The immensity of the task when tackled by the old methods seemed so great, and the consequent delay so inevitable, that Kapteyn proposed that astronomers should concentrate their attention on certain selected areas which might be taken as representative samples of the whole sky.

A rude analogy will perhaps help us. The old way was something like studying the condition of England by means of a "Burke's Peerage" or a "Who's Who." Kapteyn proposed as better a limited number of selected areas, some urban, some rural; but the blink method will easily cover the whole area and permit an exact census to be taken.

The present state of astronomical science is one of great activity, but I have only time to make some brief references. The activities of the Union Observatory, an institution originally started by our association, call for some mention. The late Mr. Franklin-Adams planned a photographic chart of the whole sky, and more than half of the plates were taken at the Union Observatory. These were forwarded to the Astronomer Royal at Greenwich, and are undergoing examination. Some of the first results of this examination have been published in the Memoirs of the Royal Astronomical Society. Counts of the stars on these plates have been made by Messrs. Chapman and Melotte,[4] from whom the following figures are taken:—

Galactic Latitude	Plates taken in S. Africa	Plates taken in England
0° to 15°	988,000	515,000
16 to 30	616,000	383,000
31 to 50	406,000	230,000
51 to 90	307,000	145,000

This little table invites two comments—one is that the purity of the atmosphere has resulted in many more stars (nearly twice as many) being found on the plates taken at the Union Observatory; the other that the richness of the plates decreases more or less uniformly as the galactic plane—the Milky Way—is left. Chapman and Melotte also give this table, show-

[4] Mem. R.A.S., x.

ing the total number of stars in the sky, arranged according to magnitudes :—

Magnitude	Number	Magnitude	Number
2·0	38	10·0	272,000
3·0	111	11·0	698,000
4·0	300	12·0	1,660,000
5·0	950	13·0	3,680,000
6·0	3,150	14·0	7,650,000
7·0	9,810	15·0	15,500,000
8·0	32,360	16·0	29,500,000
9·0	97,400	17·0	54,900,000

So actually, the Franklin-Adams plates locate for reference at any time about 100 million stars, and these may be said to be all the stars known to astronomers. Special plates taken with the largest telescopes indicate a much larger number of stars—perhaps ten to fifteen hundred million in all. It will be noticed that the ratio from one magnitude to another, which is larger than 3 at the beginning of the table, progressively decreases, and is already less than 2 for the 15–16 magnitude; hence the authors conclude "that modern photographic telescopes penetrate to a distance at which the stars begin to thin out fairly quickly either really or by absorption."

Variation of Latitude.

Since March, 1910, and until December, 1914, the Union Observatory has, aided for some years by a subsidy from the International Geodetic Bureau, taken part in a scheme of observations for measuring the variation of latitude. I must be brief, and will only say that the question at issue was: "Is this variation common to the whole globe, or is it in part or wholly due to the elasticity of the earth, so that the deformation in the northern hemisphere might be different from that of the southern hemisphere?" The result of our observations to March, 1913, proves that in the variation of latitude the earth moves as a solid. In Dr. Albrecht's own words :—

"From this series of observations we can deduce an interesting confirmation of the result, previously obtained, that the values of the quantities *x*, *y*, and *z* deduced from observations made in the northern hemisphere, can be applied without any modification to the variation of the latitude in the southern hemisphere." [5]

Gravitation.

For upwards of half a century it has been known that the law of gravitation seems to be insufficient to account for all the planetary motions—the most conspicuous exception being the motion of the perihelion of Mercury's orbit—and it has been found more recently that it is impossible to reconcile the moon's motion with gravitation. Recently Sir J. Larmor and Mr. H. Glauert have proved that a certain amount of these irregularities are due to variations in the length of the day; Glauert finding that the length of the day has increased by a hundredth of a second in a third of a century. This means that as compared with a third of a century ago, the year will appear to be about 3½ seconds longer. Such a change, because of our methods of determining time, will be most clearly reflected in the motion of the first satellite of Jupiter, the eclipses of which can be observed with an accuracy of about one second, and the motion of which is the most purely periodic that is known. Since 1908, every visible eclipse of this satellite has been observed at the Union Observatory, so that in the course of time we may expect that our observations may assist in the solution of an obscure problem.

In dealing with the structure of the sidereal universe, or in a smaller way with the dynamics of a star-cluster, it is often tacitly assumed that gravitation is the only force at work. That gravitation is not

[5] Rapport sur les Travaux du Bureau Central en 1914, p. 6.

universally applicable we see in the solar system in the phenomena of comets' tails, and even more so in the disintegration and disappearance of periodic comets such as those of Biela and Holmes. Many double stars are undoubtedly subject to the law of gravitation in all its purity, but in far many more gravitation appears to be at most only a secondary (thus in the case of double stars of which both components are of the helium type, there do not appear to be any signs of gravitative action between the two stars). It is true that stars with variable radial velocities have been found spectroscopically, and their orbits deduced by purely gravitational principles, but in many of these cases it is not indubitably certain that the shift in the lines of the spectrum is due to recession or approach. The difficulty is that in the so-called earlier type of stars, it is found that the H and K lines of calcium do not share in the variable motion on which the binary orbit is based. The interpretation of spectra—the contradictory behaviour of different lines, their thickness and intensities—still provides problems to be solved. In this connection one must refer to the illuminating papers by Dr. Nicholson on the relation between atomic structure and the lines in the spectrum. Nicholson's work makes much use of the spectra of nebulæ, in which we see matter under simpler conditions than is possible on earth. At this meeting Prof. Malherbe is reading a paper upon "Atoms, Old and New," which will go further into this subject than is possible here.

Organisation of Astronomy.

In the earlier part of this address I dwelt upon the power of organisation under scientific direction. I am tempted to develop the subject, limiting my example of organisation to the science of astronomy, which is truly international in its aims. Astronomers are scattered all over the world, and pursue their work independently of the people amongst whom they live, and who provide the money necessary for their existence. The people are not ungenerous, but they cannot be critical. The astronomer is on his honour as it were, and this is nearly good enough, but not quite. If the astronomer is a man of sufficient initiative and energy with a regulated imagination, he will not require much supervision, but he may feel that without the co-operation of his colleagues spread over the world his work may be one-sided. He sees the need for organisation, and such organisation is not quite unknown, and has been found beneficial. Such occasional events as the transits of Venus and total eclipses of the sun generally lead to some loose co-operation. More organised affairs were the Star Catalogue of the *Astronomische Gesellschaft* (a society having its headquarters in Germany, but with international aims). It divided the sky into zones, and allotted these to certain observatories, which were willing to co-operate. The catalogues actually published have been contributed by Austria, England, Holland, Germany, Norway, Sweden, Russia, and the United States. This organised effort, started in 1868, is still going on. The other and more important organisation is that of the *Carte du Ciel*, started in 1887, and in which our first president took a leading part—he was connected with it from its inception, and when he died he was the president of the Commission. The scheme for the variation of latitude observations is also an international organisation.

All these organisations were voluntary. In every way they were useful. The problem is whether we can extend the organisation to the whole body of astronomers, and yet not destroy their initiative. A control, however light, which would destroy initiative would be fatal. At present many observatories furnish an annual report. Thus the Royal Astronomical

Society in London publishes reports from most of the observatories in the Empire; the *Astronomische Gesellschaft* does the same for all the German, many Continental, and a few American observatories; the French Government publishes the annual reports of all French observatories. Other observatories furnish annual reports to their own Governments or controlling bodies, and some of these are printed and circulated. Still other observatories, and these in no small number, publish no reports. The change I advocate is a very small one; it is that every observatory should furnish an annual report to its authority, and that these authorities should transmit the reports to an international association of astronomers, for comment and return. The report should be divided into sections somewhat as follows:—(1) Working staff of observing astronomers, non-observing astronomers, comprising computors and ordinary assistants; (2) detailed list of instruments which cost more than 250*l.* apiece; (3) how many observers have permanent quarters in the grounds? how many non-observers have ditto?; (4) efficiency of those instruments in past years in percentage of hours available for work; (5) observations secured in past year; (6) observations published, being prepared for publication, etc.; (7) unpublished observations made in previous years—reason for non-publication; (8) projected lines of work; (9) general notes and explanations.

All these reports should be examined and analysed by a committee of the international association and then published. The committee would then make its suggestions to the controlling bodies, leaving these to act on them or not. In this way the careful minister or even the conscientious member of Parliament could find out the opinions which an expert body holds concerning the institution for which he is asked to vote money. The advisory body could suggest to those astronomers who have sufficient equipment, but make no use of it, useful lines of research. The ardent astronomer who cannot persuade his Government to provide funds would find himself in a stronger position when he has behind him an international body. The lethargic astronomer would find that his colleagues elsewhere look to him to do his share. Better than all, it might be possible to arrange that research students could visit and work at observatories the equipment of which is not in full use. It would be invidious to give examples of observatories not working up to their potentialities—few can—but several make no attempt at any work, and have become little better than sinecures[6]—it must suffice to say that at least two of the observatories possessing exceptionally large refracting telescopes have not contributed one month's work from them in the last twenty years—their expensive equipment is idle and slowly deteriorating—the output from many others is disappointingly small. If some international association had the power to recommend that these great telescopes were put into commission, or, better still, to assign research students to their use, it would be a good thing.

In ancient days princes and men of wealth founded religious institutions called abbeys and monasteries. They did so because they considered they were helping the cause of humanity—and for centuries these bodies did respond to a real need—but the need passed, and only effete institutions remained—ultimately to be swept away—and to-day princes and men of wealth do not found abbeys. In modern times—the most ancient observatory is not old—princes and men of wealth found observatories because they consider they are helping the cause of humanity. It is unnecessary to push the analogy. The ardent astronomer will not permit it to be pushed too far; he will organise with his colleagues for the advancement of his science, and the consequent enlargement of man's intellectual horizon.

I have only dealt with the organisation of a branch of science somewhat widely detached from the current activities of the world. It would have been too ambitious to sketch the organisation of a State or of humanity at large. But such organisation must come. The war every day is showing us how necessary it is to organise for production—even if only in the munitions of war—and not for profit. We are living in dangerous times, times in which it behoves the man of science, who is actuated by no selfish interests, to exert his power in remoulding the new society when the time, now near at hand, comes.

The notable discussion in the House of Commons on May 13 last (reprinted in Nature of May 20) on the motion of the Government to form an Advisory Council on Industrial Research, sets an example, which is sure to be followed by other British communities. All the debaters spoke of the extraordinary example of Germany rising to great material power through the spread of technical education and scientific research. No country can afford, or would be justified, in lagging behind, but a more ethical objective should be the ideal.

In South Africa several problems have suggested themselves, but the experimental work would be very costly, and might, after all, be insufficient, so that their solutions do not appeal to private enterprise. The local production of liquid fuel is one of these problems. Liquid fuel can be made both from low-grade coals and from agricultural produce, and it is within the range of probability that what to-day are considered noxious weeds, such as the prickly pear, might have an economic value in the production of alcohol. Again, the extraordinarily favourable duration of sunshine in the Union invites the trial of sun-power boilers, especially for pumping. A census of the water power "white coal" is also desirable, because if we have no great falls of water excepting the Victoria Falls, we must remember that our high veld rivers have a descent of 6000 ft. to sea-level, some of which is probably economically available.

If science is co-ordinated knowledge, what is the man of science? The true type is a man of faith, believing in the power of co-ordinated knowledge to make the world a purer and a better one. If the object of science was only the material conquest of nature it would be unworthy, and sooner or later it would be rejected by mankind. The faith of the man of science is unlimited—he might declare his creed in words somewhat as follows[7]:—

"I believe in the ultimate distinction between Good and Evil, and in a real Process in a real Time. I believe that it is my duty to increase Good and to diminish Evil. I believe in doing so I am serving the purpose of the World. This I know and I do not know anything else; I will not put questions to which I have no answer, and to which I believe no one has an answer. Organic Action is my creed, Abstract speculation weakens Action. I do not wish to speculate; I wish to act; I wish to live."

Or, he says, using the words of Bacon:—

"The knowledge of Truth, which is the Presence of it; and the Beleefe of Truth, which the Enioying of it; is the Soveraigne Good of Humane Nature. The first Creature of God, in the workes of the Dayes, was the Light of the Sense; The last, was the Light of Reason; And His Sabbath Worke, ever since, is the Illumination of His Spirit."

6 They may provide a time or meteorological service of some local importance, but as institutions for research work of any kind their efforts are negligibly small. At least 33 per cent. of the observatories listed in the Nautical Almanac publish nothing.

7 Adapted from "Appearances," by G. Lowes Dickinson (1914).

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING.

THE ninth annual report of the president and the treasurer of the Carnegie Foundation for the Advancement of Teaching, for the year ending September 30, 1914, shows a total endowment of 2,850,000*l.*, a surplus of 249,000*l.*, an annual income of 149,200*l.*, and an annual expenditure of 143,200*l.* Of this 6400*l.* was spent in administration, 9400*l.* in educational inquiry, and 126,800*l.* in retiring allowances and pensions. During the year twenty-nine retiring allowances and fifteen widows' pensions were granted, the average grant being 329*l.* 10*s.* The total number of allowances now in force is 332, the total number of widows' pensions 100, the general average grant being 319*l.* The total number of allowances granted since the beginning of the foundation is 595, the total expenditure for this purpose being 710,200*l.*

A comprehensive study of engineering education has been undertaken at the request of a joint committee representing the six national engineering societies. In co-operation with these societies a study of the history of important engineering schools and land-grant colleges has been made. Numerous engineering schools have been visited, special studies are being made of the situation of the student upon entering and upon leaving his engineering studies, and several thousand engineers are co-operating in formulating the views of the profession concerning the present methods and results of the engineering schools.

Because engineering is relatively a new profession, its professional consciousness is not as well developed as that in medicine and law, as is evidenced by the fact that engineering societies are of comparatively recent date. Thus the American Society of Civil Engineers, organised in 1852, held its first convention in 1869. The similar organisations of the mechanical and the electrical engineers were formed in 1880 and 1884 respectively.

Because of this newness of the demand for engineers, the engineering schools of the United States have had to do much pioneer work in education. Founded, as most of them were, since 1860, in response to the needs of growing industries for men trained in applied science, they have had to blaze their own trail through the forests of educational tradition; and, particularly in the early years of their existence, have had to defend their practices against existing habits of educational procedure. This fact makes the study of engineering education one of particular interest and importance, since it inevitably led to modifications in school practices both in the engineering colleges themselves and in the colleges for liberal humanistic training.

Although engineering was much simpler when the colleges were established than it is now, the founders of these institutions recognised clearly the novelty of the demands they were trying to meet, and organised their schools with a definite purpose of meeting those demands as fully as possible. The curricula of the early schools were devised only after a careful study of the conditions which the young engineer would have to meet on emerging from his course. That these curricula and the methods of training used were well adapted to the purposes for which they were devised is shown by the admirable results obtained. The wonderful development of the country in industrial and technical lines is in no small measure the work of the graduates of the engineering colleges, and stands as a monument to the far-sightedness, the sound instincts, and the high ideals of the men who guided the work.

But this rapid expansion in industrial and technical lines, aided at every turn by the equally rapid development of science, has resulted in making the field of engineering very broad and extremely complicated. Engineers have been forced to specialise in limited fields, and each year has witnessed a higher degree of specialisation and an increase in the amount of subject-matter which must be included in the curricula of the schools. To meet this situation, the engineering schools have gradually patched the original curriculum by adding new subjects here and there and subdividing their instruction into an ever-increasing number of more highly specialised courses. The demands on the student's time have become severe, and the ingenuity of faculties to frame time-schedules which shall satisfy the requirements of all the various departments is being taxed to the utmost.

That there is a pressing need for a full and thorough study of engineering education is clearly recognised by the engineering profession. This recognition has manifested itself in the organisation, in 1893, of the Society for the Promotion of Engineering Education, and in the increasing attention which the engineering societies and the engineering Press have given to this subject. It has recently been clearly expressed by the appointment of a joint committee on engineering education, whose membership is made up of fifteen representatives of the leading national engineering societies, and whose function is "to examine into all branches of engineering and to formulate a report on the appropriate scope of engineering education."

The Carnegie Foundation is undertaking this study of engineering education in close conference and hearty co-operation with this committee. An important part of this inquiry will consist in a study of the conditions into which a young engineer enters immediately on graduation, and of the estimates which the engineering profession has formed of his needs and his equipment. Another part of the inquiry will consist of a study of the aims, the purposes, the curricula, the methods of teaching, and the educational experiments and investigations of the engineering schools. Such material, arranged in compact form, should be of value to schools and teachers, no less than to engineers and students.

The steps being taken to found an American Association of University Professors are of interest to all workers in higher education.

The movement has been inaugurated by a meeting held in Baltimore for the formation of a national association of university professors. For some years university teachers have realised that specialisation in teaching tended more and more to bring them together as specialists, not as unversity teachers. The physiologists, chemists, and philologists meet in groups, but nowhere has there been provided a body under which all university teachers shall come together, not as specialists but as university teachers, to consider the problems and the organisation of higher education. Such a body ought to be able to promote in a helpful way the discussion of questions relating to higher education and to the organisation and conduct of our universities; such, for example, as the organisation of universities into departments, the relations of research to teaching, the awarding of degrees, the methods of appointment and promotion, the relations of faculties and trustees, and numerous other questions directly affecting the ideals and the needs of university teachers and affecting no less the progress and development of the universities themselves.

Such a body bringing together university teachers in all subjects, who meet not as specialists but as men engaged in teaching, ought to exercise an admirable influence in arousing in the minds of a large number of university teachers now absorbed in their own specialities an interest in university questions and a greater readiness to study such questions together. Too many university teachers are content to be absorbed in their own fields of study or research, and give little time or thought to the larger problems of university life and university progress. Such a body as this ought to furnish the opportunity and the incentive towards such thinking.

Such an organisation of university teachers ought to accomplish much in the creation of what one might call professional consciousness. It will help towards a more definite appreciation on the part of teachers themselves, and on the part of the public, of what it means to be a university teacher. The association may well hope in time to grow into an influence comparable in the case of university teachers to that exercised by the American Bar Association for lawyers or by the American Medical Association for physicians. Hitherto there has been little of professional solidarity amongst university teachers. The term professor has had with us a very indefinite meaning. It has been applied unthinkingly to secondary-school teachers, college teachers, university teachers, and to many whose connection with teaching is most remote. In this uncertainty lie certain difficulties which the association will meet, for in the public mind there is as yet no very clear differentiation between the university professor and the secondary-school teacher; just as many of our universities are such in name only.

The plans of the Association of University Professors have not yet been worked out to the point of detailed organisation. Doubtless those who have the matter in charge have in mind a somewhat loose organisation like that of the lawyers rather than a highly detailed organisation like that of the physicians. So far as the plan has as yet developed, it contemplates nothing further than the formation of a body representative of university teachers, a body in which questions affecting the work of the university and the interests of teachers, the relations of schools and colleges, and similar questions, may be discussed from the point of view of university teachers, and which may present to university bodies and to the public a statement of such questions from the point of view of the profession itself. Those who have to do with universities and colleges, whether as trustees, presidents, or teachers, will welcome this movement heartily.

The foundation's earlier studies of medical education are continued in this report in recommendations for changes in the classification of medical schools; a study of medicine and politics in Ohio; and a survey of medical education on the Pacific coast, which shows that the State of Washington, which has no medical school, has a plentiful supply of physicians trained in good schools all over the country, while California, with eight medical schools, is swamped with poorly trained doctors.

The report concludes with a discussion of "Standards and Standardisers," which shows that the Carnegie Foundation has had little to do with the setting up or enforcement of college standards, this being the work of college faculties. All that the foundation has done is to cause fuller discussion of such matters and to urge the claims of honesty and sincerity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A BURSARY in memory of Mr. Robert Hepburn has been founded by his sister at University College, Dundee. It will be tenable for three years, and open to any male or female student of medicine at the college.

PROF. W. MORGAN, who fills the chair of automobile engineering in the faculty of engineering of the University of Bristol, has been released from his duties for the period of the war. He will, we understand, be engaged upon work in connection with the production of munitions.

THE governors of Guy's Hospital have received from the trustees and executors of the will of the late Sir William Dunn 25,000*l.* new War Loan $4\frac{1}{2}$ per cent. fully-paid stock for the endowment of a lectureship in pathology in the Guy's Hospital Medical School, to be known as the "Sir William Dunn Lectureship in Pathology."

IN connection with the erection of the permanent buildings of the University of Western Australia, two prizes of a hundred guineas and twenty-five guineas respectively were offered for the two best designs for the laying out of the University's grounds at Crawley Park, Perth, W.A. A large number of designs were sent in, and the following awards have now been made by the board of adjudication:—First prize, H. Desbrowe-Annear, Melbourne, Victoria; second prize, H. W. Hargrave, Perth, W.A. The design submitted by Messrs. J. Cheal and Sons, Ltd., Crawley, Sussex, has in addition been granted an honourable mention.

WE are requested to make known that the latest date for the receipt of applications from candidates desiring to be examined at Local Centres for the Aitchison Memorial Scholarship is September 1, and from those who wish to be examined in London, September 15. Applications should be made to Mr. H. F. Purser, 35 Charles Street, Hatton Garden, E.C. It will be remembered that the scholarship in question was founded in memory of the late Mr. James Aitchison, in consideration of the many and valuable services rendered by him to the optical industry and the development of optical education, and specially in recognition of his unselfish and constant endeavour to secure better training for optical students. The scholarship course, tenable at the Northampton Polytechnic Institute, Clerkenwell, covers two years, and its total value is 30*l.* It is proposed to offer the scholarship in alternate years.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 17.—M. Ed. Perrier in the chair.—Paul **Appell**: Contribution to the study of the Θ functions of higher degrees.—W. **Kilian** and Antonin **Lanquine**: The coexistence, in the neighbourhood of Castellane, of pyreneo-provençal dislocations and of Alpine folds, and on the complexity of these orogenic phenomena.—Joseph **Pérès**: Bessel's functions with several variables.—H. G. **Block**: The equation of elastic rods.—José Rodriguez **Mourelo**: The phototropy of inorganic systems. The case of calcium sulphide. These sulphides were made by heating precipitated chalk (100 gr.), common salt (0·1 gr.), sodium carbonate (0·03 gr.), sulphur, and certain phosphorogens, such as manganese and bismuth salts. The colour develops in a strong light, not sunlight, in two or three minutes. In one set of experiments the proportion of manganese added varied between 0·1 per cent. and 0·0001 per cent. The observed colours passed through reddish-violet, pink, to an intense violet, the maximum phototropic effect being obtained with 0·005 per cent. of manganese. The colours were increased in intensity by the addition of both manganese and bismuth.—M. **Pontio**: A method of control for rapidly estimating the quantity of nickel deposited in nickel plating. The method is based on the use of a solution of dilute hydrochloric acid and hydrogen peroxide, which attacks the underlying metal (copper, iron) more rapidly than the deposited nickel.—Alberto **Betim**: A layer of euxenite in Brazil. This deposit was found near Pomba (Minas-Geraes), Brazil. A spectrographic analysis of the mineral showed the presence of titanium, niobium, yttrium, ytterbium, erbium. Chemical analysis proved uranium (4 to 11 per cent. of the oxide), thorium, traces of cerium, tin, arsenic, lead, gallium, and gold.—Ed. **Delorme**: A new mode of grafting the flexor tendons of the fingers. In cases of severe wounds of the palms of the hands, with loss of one or more of the flexor tendons, an operation has been devised, full details of which are given, in which portions of the flexor tendon of the fore-arm are grafted over on to the hand.—E. **Kayser**: Contribution to the study of the ferments of rum. It is shown that the use of the microscope can render great services in rum manufacture: it can prove contamination, and direct the fermentation to obtain products of constant composition.—Em. **Bourquelot** and A. **Aubry**: The influence of soda on the synthetic and hydrolytic properties of α-glucosidase (glucosidase from low yeast, air dried). A set of ten experiments, in which the proportion of caustic soda was gradually increased, gave results showing that the synthetic reaction was not sensibly affected so long as the mixture remained acid. In a neutral mixture the reaction does not attain its normal equilibrium, and with distinct alkaline reaction the synthetic reaction stops, although no secondary isomerising reactions have been set up by the alkali.

NEW SOUTH WALES.

Linnean Society, June 30.—Mr. A. G. Hamilton, president, in the chair.—A. R. **McCulloch**: Notes on, and descriptions of, Australian fishes.—H. S. H. **Wardlaw**: The temperature of *Echidna aculeata*. The temperature of Echidna shows a regular daily variation of about 3° C., its morning temperature being about 30° C., and its afternoon temperature about 33° C. These temperatures are considerably lower than the temperatures of most other mammals (37° C.). During winter in Sydney, Echidna hibernates for short periods at a time. During the periods of hibernation, its temperature sinks almost to the level of the air, so that Echidna behaves like a cold-blooded animal.—R. J. **Tillyard**: The development of the wing-venation in zygopterous dragon-flies, with special reference to the Calopterygidæ. The paper deals with the tracheation of the larval wing in the genera Calopteryx (Palæarctic) and Diphlebia (Australian), the only two genera of the Calopterygidæ available for study. The results are most important, since they establish the fact that, throughout the suborder Zygoptera, the radius is unbranched, whereas in the Anisoptera it always possesses a branch, known as the *radial sector*, which crosses over the two most distal branches of the media. In the Anisoptera, the media has only three branches besides the main stem. In the Zygoptera it has *four*. The extra branch lies between M_2 and M_3, and is *analogous* to, but not *homologous* with, the radial sector. For this newly demonstrated branch the name *zygopterid sector* is proposed, with the notation Ms, to preserve the analogy with the radial sector Rs. Important results following from this are (1) that the crossing of Rs over M_{1-2} no longer separates the Odonata from all other insects; (2) that the dichotomy between Anisoptera and Zygoptera becomes far more pronounced than heretofore, by the basic difference in the condition of the radius in the two suborders; (3) that Handlirsch's fossil suborder, Anisozygoptera, must be dropped; all these fossils, tested by the character of the radius, become true Zygoptera.—Dr. S. J. **Johnston**: *Moreauia mirabilis*, gen. et sp.nov., a remarkable trematode parasitic in Ornithorhynchus. This worm lives in the anterior part of the intestine of the platypus, in the spaces between the transverse folds of the mucous membrane, where it lies completely hidden. It is remarkable in its lateral expansion, being five times as broad as it is long. It is so different in its structure from known forms that it is looked upon by the writer as the representative of a new subfamily with fairly close affinities to Liolopinæ.

BOOKS RECEIVED.

The Yearbook of the Universities of the Empire, 1915. Pp. xii+717. (London: H. Jenkins, Ltd.) 7s. 6d. net.

The National University of Ireland. Calendar for the year 1915. Pp. clxxxiv+583. (Dublin.)

Thèses présentées à la faculté des Sciences de l'Université de Paris. Série A. No. 764. Pp. 155. (Marseille: Barlatier.)

Outlines of Sociology. By Prof. F. W. Blackmar and Dr. J. L. Gillin. Pp. viii+586. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 8s. 6d. net.

Elementary Algebra. By F. Cajori and L. R. Odell. Pp. vi+206. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 3s. net.

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SUPPLEMENT TO "NATURE."

MEMBERS OF SCIENTIFIC STAFFS OF UNIVERSITIES, COLLEGES, AND OTHER INSTITUTIONS ON ACTIVE SERVICE WITH H.M. FORCES.

MANY of the universities, colleges, and technical institutions in the United Kingdom have prepared lists of members of the staff, and of past and present students, serving with the forces of the Crown during the present war. Men engaged in teaching scientific and technical subjects, or in research, at these institutions have, in common with other professional classes, put aside their work voluntarily at the call of their country and taken their places in various branches of naval or military service. It has been our sorrowful duty to record that several workers in science have met their deaths while thus employed; and on such occasions the thought of others in the field has always been before us. In order to obtain a rough census of men on active service, we have communicated with the registrar of each university and university college in the United Kingdom, and also with the principals of the technical schools and colleges included in the Association of Technical Institutions. We asked for the names of members of the scientific staffs now serving with the Army or Navy, with their positions on the staffs and rank in the forces. From the information thus obtained we have been able to compile the subjoined list, which will be of interest to many readers of NATURE.

Medical men have only been included in the list when their names have been sent in as those of members of general scientific staffs. It would be out of place for us to attempt to prepare a list of the thousands of medical men serving in the Royal Army Medical Corps, the work of which must command the admiration of the whole civilised world. We are also unable to give the names of the many men whose scientific and technical knowledge are being used in the provision of munitions of war and for other national services at home. One technical school informs us that its workshop is now turning out a large number of shells a week, and another that the three engineers on its staff are, in addition to their teaching duties, performing war service by making munitions in the engineering workshops connected with one of the Royal factories.

In presenting the subjoined list, it may be desirable to repeat that it is limited to members of scientific staffs of the institutions named. The number of past and present students serving with the King's forces is greater than could ever have been anticipated. The Oxford roll has 8000 names, Cambridge has nearly 9000, Edinburgh 4000, the Imperial College of Science and Technology 1200, and other universities and colleges are similarly represented. The recent report of the Board of Education for the year 1913–14 (Cd. 7934) gives some striking facts as regards the decrease thus caused in the number of students in English colleges. From thirty-four universities and university colleges in England and Wales which are aided by grants from the Board, 2530 full-time students, or about 30 per cent. of the total number of full-time men students, had withdrawn to join the Forces by the end of January, and it may be safely assumed from the activity of the Officers Training Corps attached to these institutions that the number will steadily increase. In the men's training colleges for elementary teachers (excluding university training departments) about 645 out of a total number of 1420, or about 45 per cent., are already serving with the Forces, and it may be anticipated that others will join, if required, at the conclusion of the summer term. For the technical, art, and evening schools it is not possible to give even approximate figures; but a number of the larger institutions have estimated the drop in the number of students owing to the war at points ranging up to 50 per cent., and averaging about 26 per cent.

ABERDEEN: UNIVERSITY.

Cranston, A., researcher in chemistry department, 2nd Lieut. 9th Batt. Royal Scots Fusiliers.
Duncan, Geo. M., lecturer in bacteriology, Capt. R.A.M.C. (T.F.)
Findlay, W. M., university assistant in agriculture, Lieut. Gordon Highlanders (T.F. Reserve).
Geddes, A. E. M., univ. assist. in natural philosophy, Lieut. Royal Army Flying Corps (Meteorl. Section).
Haig, Harold H., research fellow (pathology), Lieut. (Temporary), R.A.M.C.
MacQueen, J. M., research fellow (pathology), Capt. R.A.M.C. (T.F.)
Murray, Dr. J. R., university assistant in physiology, Lieut. (Temporary), R.A.M.C.
Orr, Dr. J. B., researcher in animal nutrition (Dept. of agriculture), Lieut. (Temporary) R.A.M.C.
Pratt, J. D., university assistant in chemistry, 2nd Lieut. 4th Batt. Gordon Highlanders (T.F.).
Stuart, G., university assistant in anatomy, Capt. R.A.M.C. (T.F.).
Thomson, A. L., univ. assist. in zool., 2nd Lt. (Temp.) 13th Batt. Argyll and Sutherland Highlanders.

ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES.

Bury, assistant-lecturer and demonstrator in chemistry, 2nd Lieut. Gloucester Regiment.
Grant, R., county agriculture organiser for Pembrokeshire, 2nd Lieut. Welsh Regiment.
James, T. C., lecturer and demonstrator in chemistry, Lieut. College O.T.C.
Paine, H. H., assistant-lecturer and demonstrator in physics, Capt. Royal Welsh Fusiliers.
Walton, C. L., assistant-lecturer in economic zoology, 2nd Lieut. College O.T.C.
Williams, R. D., instructor in veterinary hygiene, Major Royal Army Veterinary Corps.

ASPATRIA AGRICULTURAL COLLEGE.

Charleton, L. S., lecturer in surveying and book-keeping, Lieut.

ASTON: TECHNICAL SCHOOL.

Nash, J. H., teacher of mechanical drawing, private, Birmingham City Batt., 15th R. Warwick Regt.

BARROW: TECHNICAL INSTITUTE.

Baythorp, A. J., teacher of mechanical drawing, Lieut. Royal Garrison Artillery.
Milne, K., teacher of mechanical drawing, private, Yeomanry.
Seed, D., teacher of mechanical drawing, 2nd Lieut Royal Garrison Artillery.

BELFAST: MUNICIPAL TECHNICAL INSTITUTE.

Adair, J. T., teacher of flax spinning, Lieut. Bedfordshire Regiment.
Forth, F. C., principal, Capt. Royal Irish Rifles.
Gooch, H., lecturer in physics and electrical engineering, Lieut. Royal Engineers.
Longworth, G. H., engineering workshop instructor, Staff-Sergt. Army Ordnance Corps.
Naylor, T. M., lecturer in mechanical and electrical engineering, Eng. Sub-Lieut. Royal Navy.
Nixon, W., teacher of naval architecture, Capt. Tyneside Scottish.

Stanley, R., professor of physics and electrical engineering, Capt. Royal Engineers.
Wright, T. M., instructor in physical training, Company Sergt.-Major Army Gymnastic Staff.

BELFAST: QUEEN'S UNIVERSITY.

Crymble, Dr. C. R., senior assistant in chemistry, Lieut. 3rd Batt. Royal Irish Fusiliers.
Crymble, P. T., lecturer in applied anatomy, Capt. R.A.M.C. (T.F.).
Dwerryhouse, Dr. A. R., lecturer in geology and geography, Capt. Royal Garrison Artillery (S.R.).
Emerson, E. C. T., demonstrator in anatomy, Lieut. R.A.M.C.
Glendinning, W. G., assistant in chemistry, despatch rider.
Gooch, H., extra Murch lecturer in electrical engineering, Lieut. Royal Engineers.
Harper, E. M., assistant in chemistry, 2nd Lieut. 7th Batt. Munster Fusiliers.
Livens, G., late demonstrator in botany, 2nd Lieut. 5th Batt. Wiltshire Regiment.
M'Cloy, Dr. J. M., assistant in pathology, medical officer in base hospital.
M'Connell, R. J., demonstrator in anatomy, Lieut. R.A.M.C.
Malcolm, H. P., demonstrator in pathology, Lieut. R.A.M.C.
Stanley, R., extra Murch professor of electrical engineering, Capt. Royal engineers.
Wilson, Dr. W. J., lecturer in hygiene, Lieut. R.A.M.C. (T.F.).

BIRMINGHAM: MUNICIPAL TECHNICAL SCHOOL.

Lawrence, R. R., laboratory assistant, metallurgical department, 2nd Lieut.
Legg, S., senior laboratory assistant, engineering department, private.

BRADFORD: TECHNICAL COLLEGE.

Chevalier, J. J. F., station engineer, 2nd Lieut. Mechanical Transport Section, A.S.C.
Rowell, H. S., senior lecturer, engineering department, 2nd Lieut. Royal Garrison Artillery.

BRISTOL: MERCHANT VENTURERS' TECHNICAL COLLEGE.

Chitty, H., lecturer on first aid and home nursing, surgeon, R.N.
Palmer, G. R., assistant-lecturer in mathematics, Lieut. 11th Batt. West Riding Regiment.
Rogers, Dr. B. M. H., lecturer on care of the infant and school child, Lieut.-Col. R.A.M.C.
Short, Dr. A. R., lecturer on first aid and home nursing, Capt. R.A.M.C.
Stanley, H., lecturer in physics, Lieut. 4th Batt. Gloucester Regiment.
Statham, Dr. R. S. S., demonstrator in first aid and home nursing, Lieut. R.A.M.C.
Tipton, F. N., lecturer on telegraphy, Army telegraphist in France.
Wood, E. B., research assistant in the automobile engineering dept., Lieut. Army Service Corps.

BURNLEY: MUNICIPAL TECHNICAL INSTITUTE.

Basnett, W., laboratory attendant, private R.A.M.C.
Kay, T. H., teacher of commercial subjects, private Army Service Corps.

BURY: MUNICIPAL TECHNICAL SCHOOL.

Brammall, A., head of commercial department, Corpl. (Army).
Brooks, A. W., lecturer in book-keeping, Sergt.-Maj. (Army).
Buxton, G. V., lecturer in mathematics, private (Army); killed in action June 6, 1915.
Catterall, T., head of physics department, 2nd Lieut. (Army).
Eastham, F., lecturer in physics, private (Army).
Hardman, E. S., lecturer in engineering, 2nd Lieut. (Army).
Johnson, J., head of building trades department, Corpl. (Army).
Norman, G. M., head of chemistry department, Corpl. (Army).
Tonge, H., assistant-lecturer in cotton weaving, Corpl. (Army).

CAMBRIDGE: UNIVERSITY.

Assheton, Dr. R. T., lecturer in animal embryology, 2nd Lieut. 1st Cambs.
Bragg, W. L., lecturer in natural sciences, 2nd Lieut. R.H.A. (Leics.).
Deighton, F., teacher of vaccination, Lieut. R.A.M.C.
Dunlop, J. G. M., assistant-lecturer in chemistry, Lieut. 2nd Dublin Fusiliers (died August 26, 1914).
Entwistle, F., second observer, the Observatory, Lieut.
Fay, C. R., Gilbey lecturer in agriculture, 2nd Lieut. 3rd The Buffs (East Kent Regiment).
Gray, J., demonstrator in comparative anatomy, 2nd Lieut. 5th Royal West Surrey.
Gregory, R. P., university lecturer in botany, Lieut.
Hele, T. Shirley, lecturer in natural sciences, Capt. R.A.M.C.
Heycock, C. T., Goldsmiths' reader in metallurgy, Lieut.-Col. Commanding 1st Cambs. (T.F.).
Hill, A. V., Humphrey Owen Jones lecturer in physical chemistry, Capt. 1st Cambs.
Hindle, E., assistant to Quick professor of biology, Lieut. R.E. (Signalling Section).
Hopkinson, B., professor of mechanism and applied mechanics, Major C.U.O.T.C.
Inglis, C. E., lecturer in mechanical engineering, Lieut. Royal Engineers.
Kempson, F. C., demonstrator of human anatomy, Lieut. R.A.M.C. (5th Bedford).
Lees, S., fellow of St. John's, Engineer-Lieut. R.N.
Littlewood, J. E., lecturer in mathematics, 2nd Lieut. R.G.A. (Wessex).
Lucas, Dr. K., demonstrator in physiology, Army Aircraft Factory.
Marrack, J. R. fellow of St. John's, working at the Research Hospital, Cambridge, Lieut. R.A.M.C.
Moss, W., junior observer, Solar Physics Observatory, Cadet Cambridge University O.T.C.
Myers, Dr. C. S., lecturer in experimental psychology, Major R.A.M.C.
Nicholas, T. C., sub-lecturer in geology, Staff-Major Mediterranean Force.
Parker, W. H., sub-lecturer in agriculture, 2nd Lieut. 11th Suffolk.
Peters, R. A., research fellow (physiology), Gonville and Caius, Univ. demonstrator, Lieut. R.A.M.C.
Potts, F. A., director in natural science, Trinity Hall, 2nd Lieut. 9th West Riding Regiment.
Roberts, H., lecturer in physiology and anatomy, Lieut. R.A.M.C.
Robertson, D. H., sub-lecturer in economics, 2nd. Lieut. 11th London.
Rolston, W. E., junior observer, Solar Physics Observatory, Lieut. East Kent Regt. (The Buffs).
Stratton, F. J. M., University lecturer in astrophysics, Capt. 20th Div. Syn. Co., R.E.
Thirkill, H., demonstrator in experimental physics, 2nd Lieut. R.E.
Thomas, H. H., curator of botanical museum, 2nd Lieut. Chesh. Brigade R.F.A.
Wilson, G. H. A., lecturer in mathematics, Capt. (Army).

Woodhead, G. Sims, professor of pathology, Lieut.-Col. R.A.M.C.
Wright, C. S., lecturer in surveying and cartography, 2nd Lieut. Royal Engineers.

CARDIFF: TECHNICAL SCHOOL.

Collier, R. H., teacher of motor-car engineering (elementary), Lieut. Royal Flying Corps.
Korner, L. J., teacher of oxy-acetylene welding and metal cutting, mechanic Royal Flying Corps.
Thain, T. E., teacher of marine engineering, Lieut. Royal Engineers.
Wiltshire, C. J., assistant-teacher of theoretical mathematics ii., private Royal Army Medical Corps.

CHELMSFORD: EAST ANGLIAN INSTITUTE OF AGRICULTURE.

Hunter Smith, J., agriculturist, private London Scottish, 2nd Batt.
Taylor, E. McK., analyst and lecturer in chemistry, Lieut. 5th Essex (T.F.).

CHESHIRE: HOLMES CHAPEL COLLEGE OF AGRICULTURE.

Gadd, C. H., lecturer in biology, Lance-Corporal Public School Batt. Royal Fusiliers.
Mansfield, W. S., soil chemist, Lieut. 5th Dragoon Guards.
Smith, F. Y., assistant in biology, 2nd Lieut. Royal Field Artillery.
Steele, D., assistant in agriculture, Lieut. Denbigh Hussars.

CIRENCESTER: ROYAL AGRICULTURAL COLLEGE.

Duncan, A. C., prof. of vet. sci. and bac., Lieut. attached 1st Regt. Royal Glos. Regt.
Hopkinson, A. D., lecturer in forestry, 2nd Lieut. 4th Batt. Gordon Highlanders (twice wounded).
Kershaw, M., lect. in physics and asst. lect. in chemistry, 2nd Lieut. Special Reserve (Glos. Regt.).
Saunders, C. B., lecturer in botany, 2nd Lieut. 9th Batt. the Buffs.

CORK: UNIVERSITY COLLEGE.

Cummins, Dr. H. A., professor of botany and agriculture, Major.
Harper, E. H., professor of applied mathematics, Lieut.
Magner, W., demonstrator in pathology, Lieut. R.A.M.C.
Pearson, C. B., demonstrator in surgery, Lieut. R.A.M.C.

COVENTRY: MUNICIPAL TECHNICAL INSTITUTE.

Morris, F., teacher of engineering, Lieut. Army Ordnance Corps.

CROYDON: POLYTECHNIC.

Baillie, Dr. T. C., principal, Lieut. Royal Garrison Artillery.
Price, E. C., instructor in wireless telegraphy, Sergt.-Major Royal Engineers.

EDINBURGH: EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

Bain, Dr. D., assistant-lecturer in chemistry, Sergt. Lothians and Border Horse.
Gray, M. W., research assistant in chemistry, 2nd Lieut. Scottish Horse.
Macpherson, A., assistant-lecturer in biology, trooper Lothians and Border Horse.
Steele, J. T., county lecturer in agriculture, 2nd Lieut. Scottish Horse.
Walker, J., assistant county lecturer in agriculture, Corpl. Lothians and Border Horse.
Wilson, A. F., county lecturer in agriculture, 2nd Lieut. Army Service Corps.

EDINBURGH: HERIOT-WATT COLLEGE.

Aitken, J. E., lecturer on paper manufacture, Capt. Royal Scots.
Bennet, G., demonstrator, mechanical engineering department, first-grade mechanic, R.N.A.S.
Malpas, T. G., assistant-lecturer in physics department, Lieut. 14th Royal Scots.
O'Connor, H., lecturer on gas manufacture and gas supply, Lieut.-Col. Royal Garrison Artillery (T.F.).
Ogilvie, A., lecturer on electrical wiring, Major Royal Engineers (T.F.).
White, J. L., lecturer on mechanics and mathematics, Private Lothians and Border Horse.

EDINBURGH: UNIVERSITY.

Beesly, Lewis, demonstrator in anatomy, Capt. R.A.M.C.
Bennet, W. G., assistant in chemistry, 2nd Lieut. Royal Field Artillery.
Finlay, T. M., lecturer in geology, Lance-Corpl. Scottish Horse.
Horne, R. J. M., assistant in physiology, Major Forth Royal Garrison Artillery.
Lyon, D. M., assistant in pathology, Lieut. R.A.M.C., 5th Cavalry Field Ambulance.
Mackenzie, Dr. J. E., lecturer in chemistry, Major Artillery Unit O.T.C., and Adjutant of Corps.
Mackie, John, assistant in natural philosophy, 2nd Lieut. 8th Royal Scots.
Mitchell, W. M., assistant in comparative anatomy, Lieut. Royal Army Veterinary Corps.
Todd, J. B., lecturer in engineering, Capt. Artillery Unit O.T.C.
Watson, J. A. S., lecturer in agriculture, Quarter-Master-Sergeant, Lothians and Border Horse.

EXETER: UNIVERSITY COLLEGE.

Jervis, W. W., lecturer on mathematics and geography, 2nd Lieut. 4th Devon Regiment.

GLASGOW: ROYAL TECHNICAL COLLEGE.

Agnew, J. W., lecturer in chemistry, 2nd Lieut. Highland Light Infantry (killed in action).
Bourdon, E., professor of architectural design, Staff-Capt. in French Army.
Burns, W. S., demonstrator in natural philosophy, 2nd Lieut. R.E.
Crawford, C. M'L., technical instructor, mechanic Royal Naval Air Service.
Duncan, T. B., assistant-lecturer and demonstrator in natural philosophy, 2nd Lieut. Scottish Rifles.
Ellis, A., lecturer in navigation, Lieut. R.N.M.B.R. (drowned on service).
Fraser, H., assistant-lecturer and demonstrator in mechanics, 2nd Lieut. South Wales Borderers.
Gardham, H. C., lecturer in mechanics, Lieut. Royal Field Artillery.
Gray, W. C., lecturer in metallurgy, 2nd Lieut. Highland Light Infantry.
Hardie, A. G., lecturer in tanning, trooper Lothian and Border Horse.
Heilbron, I. M., lecturer in chemistry, Capt. A.S.C.
Hossack, J. M., technical instructor, Company Quarter-Master-Sergeant H.L.I.
King, L. A. L., lecturer in zoology, Lieut. Royal Field Artillery.
Macdonald, A., signalling instructor, Chief Yeoman of Signals, R.N.
M'Donald, A., lecturer in navigation, Lieut. R.N.M.B.R.
M'Lellan, R. S., lecturer in navigation, Sub-Lieut. R.N.R.
O'Connor, H., lecturer in gas engineering, Lieut.-Col. Royal Garrison Artillery.

Paul, J., lecturer in mathematics, despatch rider, Royal Engineers.
Sinclair, J. H., lecturer in engineering drawing, Bombardier Motor Machine Guns, R.F.A.
Walsh, R. E., assistant-lecturer in mechanics, 2nd Lieut. Royal Engineers.
Warden, H., technical instructor, Staff-Sergt. A.O.C.
Wilson, Dr. F. J., lecturer in chemistry, Capt. H.L.I.

GLASGOW: UNIVERSITY.

Agar, Dr. W. E., lecturer in zoology, Capt. and Adjt. 5th (Reserve) H.L.I.
Drummond, J. M. F., lecturer in botany, Cadet Inns of Court O.T.C.
Dunkerly, J. S., lecturer in protozoology, 2nd Lieut. 12th Scottish Rifles (Cameronians).
Ferguson, D. R., assistant in engineering, private Royal Engineers.

GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE.

Fraser, J., lecturer on forestry and forest botany, private Argyll and Sutherland Highlanders.
Gillilland, T., assistant at Dairy School, trooper Scottish Horse.
King, L. A. L., lecturer in zoology, Lieut. Royal Field Artillery.
Kirkpatrick, W., junior assistant in agriculture, Corpl. Scottish Horse.
Kirkwood, J., assistant extension lecturer, despatch rider.
Malcolm, J. F., lecturer on bacteriology, Lieut. Royal Field Artillery.
McCall, J. R., professor and lecturer on veterinary science, Lieut. Royal Field Artillery.
Murray, A., extension lecturer, Lieut. Scottish Horse.
M'William, P.A., extension lecturer, Quarter-Master-Sergt. Ayrshire Yeomanry.
Perry, B. P., assistant in horticultural department, Royal Naval Volunteer Reserve Rifles.
Smith, J. W., assistant-superintendent, Experiment Station, Sergt. Ayrshire Yeomanry.

GLOUCESTER: TECHNICAL SCHOOL.

Brown, A. D., teacher of physics and applied mechanics, Sergt.

HALIFAX: MUNICIPAL TECHNICAL COLLEGE.

Blakey, E. V., assistant, chemistry department, 2nd Lieut. 3rd West Riding.
Park, H. E., laboratory assistant, electrical engineering department, private, Electrical Section, R.E.
Platt, B., assistant in mathematical department, 2nd Lieut. Royal Engineers.
Ramsden, E., assistant, mechanical engineering department, 2nd Lieut.
Sadd, J. A., head of civil and mechanical engineering department, private in Sanitary Corps.
Smith, E. W., head of chemistry department, private in Sanitary Corps.

HANDSWORTH: TECHNICAL SCHOOL.

Hilbourne, G. W., lecturer in mathematics, Lieut. in Army.
Vallance, R. F., lecturer in chemistry, private in Army.

HARPENDEN: THE ROTHAMSTED LABORATORY.

Bowden, A. H., laboratory assistant, private in Army.
Clayton, J., bacteriologist, Lieut. in Army.
Daish, A. J., organic chemist, Lieut. in Army (wounded on May 16).
Gregory, E. H., voluntary assistant on Demonstration Farm, 2nd Lieut. attached 3rd Suffolk Regiment.
Keen, B. A., soil physicist, 2nd Lieut. in Army.
Lawrence, G., laboratory assistant, Sergt. in Army.

Lewin, K. R., protozoologist, 2nd Lieut. in Army.
MacLennan, K., bacteriologist, Lieut. in Army.
Martin, C. H., voluntary worker in protozoology, Lt. in Army (killed in action near Ypres on May 3).

HUDDERSFIELD: TECHNICAL COLLEGE.

Tetley, E. W., assistant-lecturer in weaving and designing, Lance-Corpl.

HULL: MUNICIPAL TECHNICAL COLLEGE.

Dennis, W. E., demonstrator in physics department, 2nd Lieut. 9th East Yorks.
Wolff, L., assistant-lecturer in chemistry, private in East Riding Yeomanry.

LANCASTER: STOREY INSTITUTE.

Ewan, R. F., lecturer in pure mathematics, Corpl. 5th King's Own Lancaster Regiment.
Forshaw, W. S., lecturer in physics, Lieut. Manchester Regiment.
Irving, R., lecturer in practical mathematics and engineering drawing, pte. 5th King's Own Lancs.

LIVERPOOL: UNIVERSITY.

Allmand, A. J., assistant-lecturer in chemistry, 2nd Lieut. 5th Batt. Cheshire Regiment.
Angelbeck, A., tutor in geography, 2nd Lieut. 16th Service Batt. the King's Liverpool Regiment.
Balfour, W. M., assistant-lecturer in naval architecture, 2nd Lieut. Royal Garrison Artillery.
Bengough, G. D., lecturer in metallurgy, Capt. Royal Garrison Artillery.
Burfield, S. T., assistant-lecturer in zoology, 2nd Lieut. 8th Irish Batt. the King's Liverpool Regt.
Clark, J. J., assistant-lecturer in engineering design and drawing, Sergt. Cheshire Field Co., R.E.
Dod, H. A., instructor in architecture, 2nd Lieut. 18th Service Batt. the King's Liverpool Regiment.
Garstang, J., professor of archæology, inspector of twenty-five hospitals under the French Red Cross.
Harvey-Gibson, R. J., professor of botany, Lieut.-Col. the King's Liverpool Regt.
Newberry, P. E., professor of archæology, special war service.
Newstead, R., professor of entomology, special sanitation work in France.
Turnbull, G. H., assistant-lecturer in education, 10th Scottish Batt. the King's Liverpool Regiment.
Yorke, W., professor of parasitology, special Government work.

LONDON: ALDGATE, E.C., THE SIR JOHN CASS TECHNICAL INSTITUTE.

Abbot, H., lecturer on fermentation industries, 2nd Lieut. Royal Field Artillery.
Hill, S. E., assistant-teacher of physics, 20th Batt. County of London (rank unknown).
Kibble, A. W., lecturer on the fermentation industries, Sergt. Artists' Rifles.

LONDON: BATTERSEA POLYTECNIC.

Brill, D., mechanical engineering workshop assistant, private.
Curnock, W. E. M., head of department of mechanical and civil engineering, Lieut. in Army.
Godsmark, A. E., electrical engineering steward, private.
Hall, H. H., chemistry steward, private.
Matterface, J., chemistry laboratory assistant, private.
Porter, W. J., assistant-lecturer in electrical engineering, private.

LONDON: L.C.C. BEAUFOY TECHNICAL INSTITUTE.

Mitchell, J., lecturer on applied mechanics, sapper Royal Garrison Artillery.

LONDON: BOROUGH POLYTECHNIC INSTITUTE.

Chapman, E. H., assistant-lecturer in mathematical department, special meteorological work.
Cooper, W. N., assistant-lecturer in engineering department, 2nd Lieut. the Buffs.

LONDON: BRIXTON, L.C.C. SCHOOL OF BUILDING.

Bull, W. J. H., assistant science teacher, 2nd Lieut. North Staffordshire Regiment, R.M.C., Woolwich.
Freeman, R. L., teacher of quantity and land surveying, Staff-Sergt.-Major, Army Service Corps.
Murrell, H. F., teacher (assistant) of architecture, Lieut. Artists' Rifles (28th County of London).

LONDON: CHELSEA, SOUTH-WESTERN POLYTECHNIC INSTITUTE.

Nicholas, T. C., lecturer in geology (at Alexandria engaged in map drawing).
Scott, J. M., lecturer in building construction and drawing, London Scottish.

LONDON: EAST LONDON COLLEGE (UNIVERSITY OF LONDON).

Cannan, R. K., demonstrator in chemical department, 2nd Lieut. (wounded at Hill 60).
Lamb, E. H., University professor of civil and mechanical engineering, Lieut. Royal Marines.
Thurston, Dr. A. P., lecturer, aeronautical department, private London Electricals (Royal Engineers).

LONDON: GREENWICH, ROYAL OBSERVATORY.

Baldwin, G. C., computer, private.
Barton, H. H., computer, private.
Berry, A. W., computer, private.
Burkett, W. W., junior assistant, Lieut.
Chamberlain, E. A., computer, private.
Davies, W. G., computer, private.
Davis, H. W., computer, private.
Divers, S. T., computer, Quarter-Master-Sergt.
Kilby, H. H., computer, private.
Lambert, W. A., computer, private
Percival, W. G., computer, private.
Perry, P., computer, private.
Sims, R. L., computer, private.
Symms, L. S., computer, private.
Vaizey, G. R., computer, private.
Whitaker, F., computer, private.
White, P. J., computer, private.

LONDON: HACKNEY, L.C.C. INSTITUTE.

Hughes, B., lecturer in building construction, private Royal Army Medical Corps.
Ridley, W. O., lecturer in electrical engineering, Sergt., employed in wireless telegraphy work.
Webster, F. C., lecturer in building construction, Sergt. London Scottish.

LONDON: KING'S COLLEGE.

Boyd, Dr. S., lecturer in applied anatomy, 2nd Lieut. R.A.M.C. (T.F.).
Brown, Dr. Wm., reader in psychology, Lieut. 17th General Hospital, 29th Div. B. Med. Exp. Force.
Capper, D. S., professor of engineering, Lieut.-Col. Commanding University O.T.C.
Charles, Rhys, lecturer in public health, Lieut.-Col. 2nd City of London Royal Fusiliers.
de Souza, Dr. D. H., lecturer in physiology, Capt. R.A.M.C., 4th London General Hospital.
Dixon, Dr. W. E., professor of pharmacology, special service.
Hare, Dr. J. Gilbert, demonstrator in bacteriology, Red Cross Hospital.
Morrell, W. P., tutor in mathematics, Lance-Corpl. 13th Batt. Yorks. and Lancs.
Wright, T., demonstrator in chemistry, 2nd Lieut. 3rd Royal Berks. (killed in action).

LONDON: NEW CROSS, GOLDSMITHS' COLLEGE.

Fitzgerald, E., science lecturer, Capt. 20th County of London Regiment.

LONDON: NORTHAMPTON POLYTECHNIC INSTITUTE.

Barlow, E., demonstrator, electrical engineering department, Sapper R.N. Division, Engineers.
Boraston, C. A., demonstrator, electrical engineering department, 2nd Lieut. Divisional Engineers.
Hayes, M. E., assistant, mechanical engineering department, private 4th Royal Fusiliers.
Parnell, A. P., demonstrator, technical optics department, private 10th Royal Fusiliers.
Simmons, G. S., assistant, technical optics department, private 7th Middlesex.
Ware, W. J. K., assistant, technical chemistry department, private 4th West Surrey.

LONDON: NORTHERN POLYTECHNIC INSTITUTE.

Giles, A. M., physics lecturer, 2nd Lieut. Royal Engineers.

LONDON: NORWOOD, L.C.C. TECHNICAL INSTITUTE.

Cowley, H., teacher of horticulture, private 12th City of London Regiment (The Rangers).

LONDON: PADDINGTON, L.C.C. TECHNICAL INSTITUTE.

Bagenal, P. H., lecturer in architecture, private R.A.M.C.
Brown, W., lecturer in physics, Lieut.
Clarke, R. Balfour, demonstrator in engineering, 2nd Lieut. Army Service Corps.
Dearing, C., lecturer in physics and botany, private London Rifle Brigade.
Fenning, R. W., lecturer in engineering, 2nd Lieut. Artists' Rifles.
Freeman, R. L., lecturer in surveying, 2nd Lieut. Royal Engineers.
Hough, H. W., laboratory assistant, electrical engineering and physics dept., sapper R.E. (Elec.).
Morrow, H. E., lecturer in engineering, Lieut. Royal Naval Division.
Norman, H., instructor in electrical engineering, mechanic, Royal Engineers (Elec.).
Purser, W., instructor in engineering, Sergt. Royal Engineers.
Snell, A., demonstrator in engineering, mechanic, Royal Engineers.

LONDON: POPLAR, L.C.C. SCHOOL OF ENGINEERING AND NAVIGATION.

Enness, F. C., chemical laboratory assistant, private Duke of Cornwall's Light Infantry.
Gordon, D., pattern-making instructor, Lieut. Royal Naval Aircraft Service.
Palmer, F. E., drawing office assistant, sapper Royal Engineers Unit Royal Naval Division.
Pull, E., engineering workshop instructor, Warrant Engineer, Royal Navy.
Steele, J. E., naval architecture lecturer, Lieut. Royal Naval Aircraft Service.
Walker, C. A., engineering workship instructor, sapper Royal Engineers Unit Royal Naval Division.
Witney, A. H., navigation teacher, Corpl. Royal Field Artillery.

LONDON: ROYAL HORTICULTURAL SOCIETY'S LABORATORY.

Page, H. J., chemist, Lieut. Royal Artillery.

LONDON: SOUTH KENSINGTON, CITY AND GUILDS (ENGINEERING) COLLEGE.

Box, R. L., assistant demonstrator in mechanical engineering, Lance-Corpl., London Elec. Engineers.
Dickson, T. W., lecturer in mathematics and mechanics, 2nd Lieut. Jersey Militia.

Fields-Clarke, P. C. E., assistant-demonstrator in civil eng. and surveying, 2nd Lieut. 2nd Lancs Regt.
Hall, A. H., assistant-demonstrator in electrical engineering, Capt. Essex Regiment.
Hatfield, M. B., assistant-demonstrator in mechanical engineering, private Seaforth Highlanders.
Haworth, H. F., demonstrator in electrical engineering, Lieut. London Electrical Engineers (T.F.).
Klugh, H., assistant-professor in mechanics and mathematics, Sub-Lieut. R.N.V.R.
Newton, K., demonstrator in mechanical engineering, 2nd Lieut. Royal Garrison Artillery.
Pottle, A. E., assistant-demonstrator in electrical engineering, private Hampshire Regiment.
Purser, J. W., assistant-professor of civil engineering and surveying, Sub-Lieut. R.N.V.R.
Sproull, A. W., assistant-demonstrator in civil engineering and surveying, 2nd. Lieut. 127th Field Co., R.E.
Tapster, A. G., assistant-demonstrator in mechanical eng. private, 2nd Batt. 13th Co. of London Regt.
Whittaker, H., lecturer in mechanical engineering, 2nd Lieut. Royal Engineers.

LONDON: SOUTH KENSINGTON, ROYAL COLLEGE OF SCIENCE.

Curtis, W. E., demonstrator in physics, sapper Royal Naval Engineers.
Finch, G., demonstrator in chemical technology, 2nd Lieut. Royal Garrison Artillery.
Fox, H. M., lecturer in biology, 2nd Lieut. Army Service Corps.
Gibbs, I. R., assistant-demonstrator in chemistry, 1st Lieut. 10th Gloucester Regiment.
Jones, B. M., assistant-professor in chemistry, 1st Lieut., attached to Headquarters.
Lewis, R. C., assistant-demonstrator in biology, 2nd Lieut. 1st Batt. Royal Berks Regiment.
Richardson, A. R., assistant-professor in mathematics and mechanics, Maj., Headqrs., No. 1 Base, B.E.F.
Sladden, C. E., assistant-demonstrator in chemistry, 2nd Lieut. Worcester Regiment.

LONDON: SOUTH KENSINGTON, ROYAL SCHOOL OF MINES.

Chapple, H. M., demonstrator in metallurgy, Motor Cycle Division, Admir. Br. Air Service.
Courtman, E. O., demonstrator in metallurgy, Capt University of London O.T.C.
Holman, B. W., demonstrator in mining, 2nd Lieut. Royal Engineers.
Merrett, W. H., assistant-professor in metallurgy, Capt. London Electrical Engineers.

LONDON: SOUTH KENSINGTON, NATURAL HISTORY MUSEUM.

Austen, E. E., assistant, Capt. 28th (Artists' Rifles) London Regt. (attached to Army Sanitary Corps).
Blair, K. G., assistant, private 4th Seaforth Highlanders.
Dollman, J. G., assistant, private Inns of Court Officers Training Corps.
Edwards, W. N., assistant, private R.A.M.C., 3rd East Anglian Field Ambulance.
Riley, N. D., assistant, Lieut. Army Service Corps.
Smith, W. Campbell, assistant, Lieut. 28th (Artists' Rifles) London Regiment.
Stammwitz, P., taxidermist, trooper 1st County of London Yeomanry (Middlesex Hussars).
Totton, A. K., assistant, Lieut. Duke of Cornwall's Light Infantry.
Treatt, C. C., assistant, Lieut. Royal Army Flying Corps.
Wernham, H. F., assistant, private 28th (Artists' Rifles) London Regiment.

LONDON: UNIVERSITY COLLEGE.

Aveling, Rev. F., lecturer in synthetic psychology, Chaplain, 55th Division.
Crymble, Dr. C. R., demonstrator in chemistry, assistant chemical physiology, Lieut. 3rd R. I. Fusiliers.
Derry, D. E., demonstrator in anatomy, lecturer in physical anthropology, Lieut. R.A.M.C.
Filon, Prof. L. N. G., prof. of app. maths. and mech., Maj. 2nd Batt. 4th City of London Regt., R.F.
Foulerton, A. R. G., lecturer, hygiene and public health, Capt. R.A.M.C. (Sanitation Commission).
Goodbody, Dr. F. W., asst. prof. path. chemistry, Capt. R.A.M.C., attached 28th Co. of London Regt.
Green, C. M., assistant in botany, 2nd Lieut. Royal Sussex Regiment (wounded).
Gunn, J. W. C., assistant, pharmacology, Lieut. R.A.M.C.
Hill, T. G., reader in plant physiology, Capt.-Adjt. University of London O.T.C.
Jameson, Dr. W. W., assistant and lecturer, hygiene and public health, Lieut. R.A.M.C.
Kenwood, Prof. H. R., professor of hygiene and public health, Lieut.-Col. R.A.M.C. (Sanitation Commis.).
Mant, H. T., demonstrator in anatomy, lecturer in surgical anatomy, Lieut. R.A.M.C.
Simmons, E. W., demonstrator in geology, 2nd Lieut. 6th York and Lancaster Regiment.
Slade, Dr. R. E., assistant in chemistry, 2nd Lieut. Univ. of London O.T.C., special service in France.
Spearman, Prof. C., Grote professor of philosophy of mind and logic, Major, General Staff.
Venn, H. J. P., demonstrator in chemistry, Sub-Lieut. Royal Naval Division.

LONDON: WEST HAM TECHNICAL INSTITUTE.

Clarke, F. C., lecturer in mathematics, Capt. London Electrical Engineers.
Cresswell, W. T., lecturer in building construction and quantities, Major R.E.
Martin, L. C., assistant-lecturer in physics department, private R.N.D., Deal Batt.
Miller, C. P., demonstrator, civil and mechanical engineer. dept., 2nd Lieut. York. and Lancs. Regt.

LONDON: WESTMINSTER, L.C.C. TECHNICAL INSTITUTE.

Benslyn, W. T., architectural department, sapper Royal Engineers.
Bevis, J., gas engineering department, Corpl. Cyclist Batt. London Regiment.
Creswell, W. T., architectural department, Capt. Royal Engineers.
Gough, H. J., civil engineering department (rank unknown).
Webster, F. C., architectural department, Pioneer Sergt. London Scottish.

LONDON: WOOLWICH POLYTECHNIC.

Barry, P. L., chemical laboratory steward, rifleman (Q.V.R.).
Dunger, H. C. physical laboratory steward and instrument maker, Staff-Sergt. Army Ordnance Corps.
Elliott, H., lecturer in engineering, Lieut.
Franklin, P. C., lecturer in mathematics, Capt. Army Service Corps.
Frier, G. D., engineering laboratory attendant, private 20th London Regiment.
Honeybourne, H. C., assistant-teacher, physics, Capt. 20th London Regiment.
Little, E., lecturer in mathematics, Capt. Army Service Corps.
Otto, C. A., woodwork instructor and pattern-maker, sapper Royal Engineers.

LOUGHBOROUGH: TECHNICAL INSTITUTE.

Dyche-Teague, D. R., lecturer in machine construction, engineer-artificer in Navy.
Harris, J. W., lecturer in chemistry, 2nd Lieut. Yorks and Lancs.
King, J., lecturer in chemistry, 2nd Lieut. Yorks and Lancs.

MANCHESTER: SCHOOL OF TECHNOLOGY.

Gamble, C. W., director of photography and printing crafts department, Lieut. Royal Naval Volun. Res.
Hoyle, B., demonstrator in the school of technology, Lance-Corpl. Royal Engineers.
Lees, S., reader in applied thermodynamics, Eng.-Lieut. Royal Navy.
Wilson, S. P., demonstrator in the sch. of tech., 2nd Lieut. 10th (Service) Batt. South Lancs. Regt.

MANCHESTER: UNIVERSITY.

Cook, G., junior demonstrator in engineering, 2nd Lieut. Royal Garrison Artillery.
Edgar, E. C., senior lecturer in chemistry, 2nd Lieut. Manchester Univ. O.T.C. (Unattached List T.F.).
Florance, D. C. H., lecturer and demonstrator in physics, 2nd Lieut. 16th Div. Royal Field Artillery.
Holland, Sir T. H., prof. of geol., C.O. of Manchester Univ. O.T.C., Major (Unattached List, T.F.).
Jones, W. J., assistant-lecturer and demonstrator in chem., 2nd. Lieut. 12th (S.) Batt. Royal Welsh Fus.
Partington, J. R., assist.-lect. and demon. in chem., 2nd Lieut. 12th (S.) Batt. Royal Welsh Fusiliers.
Pring, J. A., demonstrator in electro-chemistry, Lieut. 8th (S.) Batt. Royal Fusiliers.
Robinson, H., lecturer and demonstrator in physics, 2nd Lieut. Royal Garrison Artillery.
Wardle, R. A., lecturer in economic zoology, private, Public Schools and Univ. Corps, Royal Fusiliers.

NEWCASTLE-UPON-TYNE: ARMSTRONG COLLEGE.

Gallon, J., prize demonstrator in mining, etc., 2nd Lieut.
Garrett, F. C., lecturer in chemistry, Lieut-Col.
Hall, A. A., assistant-lecturer in agricultural chemistry, 2nd Lieut.
Little, W. B., instructor in horticulture, Capt.
Morris-Airey, H., lecturer in physics, Lieut. Royal Naval Volunteer Reserve.
Peacock, A. D., lecturer in zoology, Sergt.
Poulton, J. H., prize demonstrator in physics, Sergt.
Ramsbottom, J. W., lecturer in economics, 2nd Lieut.
Small, J., demonstrator in botany, Corpl.
Thompson, L. A., assistant-lecturer in agriculture, 2nd Lieut.
Thompson, L. M., prize demonstrator in geology, 2nd Lieut.

NORWICH: TECHNICAL INSTITUTE.

Pond, E. W., electrical engineering assistant, private.

NOTTINGHAM: UNIVERSITY COLLEGE.

Black, T. P., registrar, late physical department, Capt.
Inchley, W., mathematics and mechanical engineering, 2nd Lieut.
Lambourne, H., chemical demonstrator, 2nd Lieut.
Piper, S. H., physical demonstrator, Lieut.
Smalley, W. M., assistant chemical demonstrator, 2nd Lieut. (killed in action December 9, 1914).

OXFORD: UNIVERSITY.

Adams, P. E. H., reader in ophthalmology, Capt. R.A.M.C.
Bazett, H. C., demonstrator in pathology, Lieut. R.A.M.C., No. 8 Field Ambulance, B.E.F.
Bourne, Dr. G. C., Linacre professor of comparative anatomy, Major 12th Worcesters.
Buxton, L. H. D., demonstrator in physical anthropology, 2nd Lieut. 4th Cameron Highlanders.
Collier, W., Litchfield lecturer in medicine, Maj. R.A.M.C.
Dodds-Parker, A. P., Litchfield lecturer in surgery, lecturer in applied anatomy, Lieut.-Col. R.A.M.C.
Douglas, Dr. C. G., demonstrator in physiology, Lieut. R.A.M.C.
Douglas, J. A., demonstrator in geology, 2nd Lieut. 3rd Gordon Highlanders.
Dreyer, G., professor of pathology, hon. consulting pathologist, 3rd Southern General Hospital.
Foster, E. C., asst. demon. in human anatomy, Major R.A.M.C., registrar 3rd Southern General Hospital.
Gibson, Dr. A. G., lecturer in morbid anatomy, Capt. R.A.M.C.
Gill, W. B., demonstrator in physics, Lieut. R.G.A.
Gunn, J. A., reader in pharmacology, Lieut. R.A.M.C.
Hasell, E. W., demonstrator in rural economy, Lieut. Westmorland and Cumberland Yeomanry.
Jenkin, C. F., professor of engineering science, Lieut. R.N.V.R. (Air Service).
Jenkinson, Dr. J. W., lecturer in embryology, Capt. 12th Worcesters, attached 2nd Roy. Dub. Fusiliers (killed in action at Dardanelles, June 4, 1915).
Ogilvie, A. G., demonstrator in geography, Lieut. 7th London Brigade, Royal Field Artillery.
Osler, Sir W., regius prof. of medicine, Hon. Col. S. Midland Division R.A.M.C.
Smith, G. W., demonstrator in comparative anatomy, Capt. 13th Rifle Brigade.
Tizard, H. T., demonstrator in physics. 2nd Lieut. Royal Garrison Artillery, attached R.F.C.
Townsend, J. S. E., Wykeham professor of physics, Lieut. R.N.V.R. (Air Service).
Walker, Dr. E. W. A., lecturer in pathology, hon. consulting pathologist, 3rd Southern Gen. Hospital.

PLYMOUTH: TECHNICAL SCHOOL.

Riley, T. N., lecturer in electrical engineering, Lieut. Naval Division (Engineers).

PORTSMOUTH: MUNICIPAL COLLEGE.

Davies, H., head of mathematical physics and electrical engineering department, Capt. Royal Eng.
Grant, L., demonstrator in physics, sapper, Hampshire Fortress, Royal Engineers.
Howes, A., lecturer in mathematics, Sergt.-Instructor 12th Batt. Essex Regiment.
Kerrison, A. V., lecturer in mathematics and physics, 2nd Lieut. Royal Garrison Artillery.
Lineham, E., lecturer in mathematics, private Mechanical Transport, Army Service Corps.
Maltby, O. B., lecturer in engineering, Lieut. Border Regiment.

READING: UNIVERSITY COLLEGE.

Auld, S. J. M., professor of agricultural chemistry, Lieut. 4th Batt. Royal Berks.
Bartlett, H. J., lecturer in geography, Sergt. 2nd South Midland Brigade, Army Service Corps.
Carter, R. H., agricultural analyst, private 1st London (City of London) Sanitary Company, R.A.M.C.
Cole, F. J., professor of zoology, 2nd Lieut. O.T.C.
Golding, J., research chemist in dairying, Lieut. R.A.M.C.
Hart-Synnot, R. V. O., dean of agriculture, Capt. 2nd Batt. (Royal Guernsey) Channel Islands Militia.
Hitchins, W. W., lecturer in building construction and surveying, sapper.
Lewin, R. R., lecturer in agricultural botany, 2nd Lieut. 3rd Batt. Royal Sussex Regiment.
McLaren, S. B., professor of mathematics, 2nd Lieut. 39th Divisional Signal Co. (Reading) Royal Eng.

Pearson, R. L., lecturer in physics, Capt. 39th Divisional Signal Co. (Reading) Royal Engineers.
Stedman, G. P. W., lecturer in machine construction and drawing, Col.-Sergt. 4th Batt. Royal Berks.

ROCHDALE: TECHNICAL SCHOOL.

Amos, P. A., lecturer on flour milling (rank unknown).
Percival, T., teacher of practical mathematics, Sergt.
Shepherd, W., assistant in chemistry, private R.A.M.C.

ST. ANDREWS: UNIVERSITY.

Butchart, R. K., assistant to the professor of mathematics, 2nd Lieut. 14th (S.) Batt. the Royal Scots.
Caldwell, J. R., assistant to the professor of pathology, Lieut. R.A.M.C. (Special Reserve).
Gibson, Dr. A. H., professor of engineering, Lieut. Royal Garrison Artillery.
Hewitt, J. A., assistant to the professor of physiology, 2nd Lieut. Royal Field Artillery.
Shann, E. W., lecturer in comparative embryology, 2nd Lieut. 12th (S.) Batt. Northumberland Fusiliers.

ST. HELENS: MUNICIPAL TECHNICAL SCHOOL.

Groves, C. R., lecturer in metallurgy, private.

SALOP: HARPER-ADAMS AGRICULTURAL COLLEGE, NEWPORT.

Powell, J. D., assistant-lecturer in agriculture, trooper.
Rhodes, F. W., lecturer in poultry-keeping, 2nd Lieut.
Urquhart, J. C., assistant-lecturer in chemistry, Lieut.
Wilson, W. T., lecturer in veterinary hygiene, Lieut.

SHEFFIELD: THE UNIVERSITY.

Armstrong, F. E., professor of mining, Red Cross.
Bartlett, A. W., assistant-lecturer in botany, private, 3rd East Anglian Field Ambulance.
Duffield, Dr. F. A., demonstrator in experimental physiology, Lieut. R.A.M.C.
Glauert, Dr. E. C., demonstrator in metallurgy, Lieut. 2/4th Batt. K.O.Y.L.I. (T.F.).
Jarrard, W. J., assistant-lecturer in chemistry, Capt. 12th Batt. York and Lancaster Regiment.
Kenner, Dr. J., assistant-lecturer in chemistry, Capt. 12th Batt. York and Lancaster Regiment.
Lightfoot, B., Sorby research fellow, Staff-Lieut. Royal Engineers.

SOUTHAMPTON: UNIVERSITY COLLEGE.

Baldwin-Wiseman, R., lecturer in engineering, Capt. 3/5 Hants.
Marle, E. R., lecturer in chemistry, Corpl. R.E.

STOCKPORT: TECHNICAL SCHOOL.

Wood, G., lecturer in engineering department, 2nd Lieut. Worcester Regiment.

SWANSEA: TECHNICAL COLLEGE.

Coe, H. I., head of metallurgy department, 2nd Lieut. 18th Welsh Regiment.
Cranage, H., lecturer in telegraphy, Lieut. Royal Engineers.
Quick, H. E., lecturer in zoology, Lieut. R.A.M.C.

TEDDINGTON: NATIONAL PHYSICAL LABORATORY.

Bell, A. H., private, Civil Service Rifles.
Blackie, A., 2nd Lieut. London Electrical Engineers.
Bramwell, F. H., Lieut. Royal Naval Volunteer Reserve.
Eastland, W. H., private 6th East Surrey.
Ewen, D., private London Scottish.
Gough, H., sapper Royal Engineers.
Grogan, J. D., private Artists' Rifles.
Jolly, H. L. P., 2nd Lieut. Royal Engineers.
Kaye, Dr. G. W. C., Capt. London Electrical Engineers.
Landells, A., Lieut. Royal Naval Volunteer Reserve.
Masters, C. H., 2nd Lieut. 8th North Staffs.
Millar, G. H., signalman Royal Naval Volunteer Reserve (prisoner of war at Döberitz).
Powell, C. H., sapper R.N. Divisional Engineers.
Stedman, E. W., Lieut. Royal Naval Volunteer Reserve.
Strand, R. R., 2nd Corpl. London Electrical Engineers.
Studd, W. J. O., Lieut. Royal Garrison Artillery.
Sturgeon, H. C., private 6th East Surrey.
Tucker, N. P., 2nd Lieut. 2nd Cameron Highlanders.
Watts, S., sapper London Electrical Engineers.

TUNBRIDGE WELLS: TECHNICAL INSTITUTE.

Ainger, F. S., lecturer on commercial subjects, Lieut. 10th Royal Sussex Regiment.
Berry, J. D., lecturer on mathematics, private Public Schools and University Corps, Royal Fusiliers.
Blakeman, A., manual instructor, Corpl. Royal West Kent Regiment.
Cogger, W., lecturer on builders' quantities, etc., despatch rider.
Hannam-Clark, H. A., lecturer on telephony and electricity, etc., Lieut. Engineers (Telegraph Dept.).
Hearmon, L., arithmetic, etc., Sergt. West Kent Yeomanry.
Jones, B., practical mathematics and physics, private Public Schools and University Corps, Roy. Fusiliers.
Lunn, H. E., lecturer on experimental science, surveying, etc., Lieut. 9th Staffs Regiment.

UCKFIELD: AGRICULTURAL COLLEGE.

Goody, G. A., lecturer on estate management, Lance-Corpl.
Holman, A. E., soil chemist and soil surveyor, Lance-Corpl.
Upperton, A., analytical department (food and drugs), private.

WOLVERHAMPTON: TECHNICAL SCHOOL.

Ellis, J. R., instructor in pattern-making, Sergt. 1/6th South Staffs Territorials.
Murray, T. J., lecturer in chemistry, Sergt. R.A.M.C., 1/3 N. Midland Field Ambulance.
Price, W., lecturer in electrical engineering, Company Quarter-Master-Sergt. Royal Engineers.

WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE.

Caukwell, C. A. B., milk recorder, Royal Engineers, Signalling Corps.
Charter, H. R., lecturer in chemistry, 7th East Surrey O.T.C.
Edwardes-Ker, D. R., head of chemical department, Capt. 5th Buffs (T.F.).
Fisher, E. A., research chemist, 2nd Lieut. Hants Royal Garrison Artillery.
Harvey, A., analyst, R.A.M.C. Sanitary Engineering Corps.
Hood-Daniel, A. F., lecturer in building construction, etc., 2nd Lieut. 5th Buffs (T.F.).
Ipswich, Viscount, lecturer in estate management, 2nd Lieut. 4th Batt. Coldstream Guards.
Jemmett, C. W., assistant entomologist, 2nd Lieut. 5th Buffs (T.F.).
Lefebure, V., research chemist, 2nd Lieut. 3rd Batt. Essex Regiment.
Reed, H. C., assistant analyst, Royal Engineers, London Wireless Signalling Corps.
Rothwell, S., lecturer in agriculture, Corpl. 5th Buffs (T.F.).
Smith, G., botany research, 2nd Lieut. 9th West Kent Regiment.
Spickernell, J. E., lecturer in chemistry, 2nd Lieut. 5th Buffs (T.F.).
Wellington, R., lecturer in fruit-growing, Corpl. East Kent Yeomanry.