THURSDAY, AUGUST 27, 1908.

FLUID RESISTANCE AND SHIP PROPULSION.

Resistance of Ships and Screw Propulsion. By Naval Constructor D. W. Taylor, U.S.N. Pp. ix+234. New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 10s. net.

A TEXT-BOOK dealing with these subjects, on the basis of scientific principles and experimental investigation, in a form suitable for the use of students, was much required when, fifteen years ago, Naval Constructor Taylor undertook the task. He was exceptionally qualified for the work, having graduated at the Naval Academy at Annapolis, and subsequently passed, with distinction, through the courses of study in naval architecture at the Royal Naval College at Greenwich, where he had the great advantage of attending lectures by Prof. Cotterill, F.R.S., and the instructors in naval architecture. Mr. Taylor's book was largely in the nature of a compilation, and based on work done by British writers, and especially on that of William Froude and Rankine. Due acknowledgment of this indebtedness was made, but the volume also contained much original work. Its presentation of facts and principles was fresh and admirable in form. The style was clear and terse; mathematical investigations were numerous and well arranged; readers were referred to original sources of information; and within two hundred pages a great mass of information was compressed. In these circumstances it was natural that the volume should be widely circulated both in this country and in the United States. It has been out of print for some years, and all interested in these subjects have hoped for a revised edition in which would be embodied work done since 1893 in connection with the resistance and propulsion of ships. The intervening period has been marked by numerous and valuable experimental investigations conducted in tanks which have been established in this country and abroad on the model of that first constructed near Torquay by the late William Froude about forty years ago.

One of the best equipped experimental establishments of this kind is that in the Washington Navy Yard, over which Mr. Taylor has presided, and for the designs of which he was largely responsible. It is much to be regretted, therefore, that the pressure of his official duties should have prevented Mr. Taylor from rewriting his book and bringing it up to date. This is particularly true in regard to the sections of the work which deal with screw-propellers. Mr. Taylor has conducted some of the most important series of experiments on model propellers yet made, and his papers published in the Transactions of the British and American Societies of Naval Architects are both valuable and suggestive. Had it been possible for him to summarise and digest his own results and those obtained by Mr. R. E. Froude, Prof. Durand and other experimentalists, he would have conferred a great service on all who are connected with ship propulsion. It may be hoped that he will yet attempt this task, for which no living writer on the subject is better qualified.

Taking the book as it stands, as an avowed reprint, it will be welcomed by shipbuilders and marine engineers, who will find therein an excellent epitome of modern theories of resistance and propulsion, and useful illustrations of the applications of these theories in practical ship-designing and the estimate of engine-power required for given speeds. Outside professional circles there are many persons interested in problems of fluid resistance who will be glad to have an exposition of the modern experimental methods which we owe chiefly to the Froudes, and a sketch of the stream-line theory of resistance on which those methods are based.

Thanks to the generosity of Mr. Yarrow, who has himself been responsible for the production of many vessels of exceptional speed and novel type, there is now a practical certainty of the establishment at an early date, in connection with the National Physical Laboratory, of an experimental tank embodying all accumulated experience and having the most modern and perfect equipment. It is true, no doubt, that the results of model experiments can only be applied within certain limits, and that they must be associated with analyses of full-scale trials of ships and propellers. The experience of forty years on the lines laid down by William Froude has established the enormous value of his experimental method in the design and propulsion of steam-ships of novel types and unprecedented speeds. There remains, however, the necessity for more extended research in order that the influence of variations in forms and proportions of ships and the characteristics of screw-propellers may be better understood. Large economies are undoubtedly still possible in the propulsion of steamships, and will be realised when systematic model experiments have been carried out by a competent staff, working on lines which have been laid down in conference with practising naval architects and marine engineers.

Herr Wellenkamp proposed recently[1] a method of experimental research on fluid resistance and ship-propulsion which would involve much less expenditure on experimental establishments and their equipment than is needed for tanks on the Froude system. In principle the method is identical with that adopted by Beaufoy in experiments made in this country for the Society for the Improvement of Naval Architecture towards the end of the eighteenth century. The motion of the model through the water is produced by a falling weight. Herr Wellenkamp was not acquainted with Beaufoy's experiments when he devised his apparatus, nor was he aware that other experimentalists—including the Hon. Charles Parsons—had used similar arrangements in recent years. He has worked out the idea in a most ingenious and thorough manner, and used a large tuning-fork as the time recorder, which marks on the revolving sur-

[1] In a paper read at the meetings of the Inst'tution of Naval Architects in April last.

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face of a drum intervals of one-hundredth part of a second. He claims to obtain almost absolute uniformity of motion for a sufficient length of run, and accurate records of the corresponding tractive force and velocity of advance during the part of the run when uniform motion occurs. The system is said to have been adopted by the German Admiralty, and in some of the technical institutions of Germany. Its operation and results will be watched with interest; but in the opinion of the writer the new method is not likely to supplant the Froude system, although it may come into use as a supplementary method of making rapid and fairly accurate "first approximations" to resistance. Even minute errors are magnified so greatly in passing from a model to a full-sized ship or propeller that the nearest possible approach to accuracy in the model experiments must be obtained, and this may justify a continuance of the greater expenditure on the experimental tanks and apparatus involved in the Froude system. Experience will decide this matter, and an extended comparison of results obtained on the old system and the new with models of identical form should afford conclusive evidence as to the best course to be followed in future. Experiment alone can be trusted, as no theoretical investigation or mathematical formulæ can deal adequately with the complex conditions of ship-propulsion.

Scientific analysis of the results obtained from systematic series of experiments on the forms of ships and propellers will certainly exercise great influence, and enable designers to proceed with greater certainty in future. There are already many examples of what may be hoped for ultimately in the published papers of Mr. R. E. Froude, Mr. Taylor and others. At present the volume of such information is insufficient, and many departments of knowledge remain obscure. As to methods of analysis, little can or need be said at present; when materials are available suitable methods will be devised. An interesting attempt to deal with the matter in the light of present knowledge will be found in a paper read before the Institution of Naval Architects by Captain Hovgaard, now professor of naval architecture in the Massachusetts Institute of Technology, and responsible for the training of the naval constructors of the United States Navy. Like Mr. Taylor, Captain Hovgaard owes his professional training to the Royal Naval College, Greenwich, and does honour to that institution. His "Analysis of the Resistance of Ships" is worthy of close study, and is based on wide knowledge of the subject. But his conclusion will commend itself to every student. "Not until tanks are established for research work . . . . will questions like the present one and many others equally important find their solution." Much may be looked for from the tank at Bushy which Mr. Yarrow has offered to establish, provided shipbuilders, marine engineers and shipowners will guarantee the cost of its maintenance. Such an offer cannot fail to be accepted, and the sooner the work of constructing the tank is begun the better will it be for British shipping.

W. H. WHITE.

LECTURES ON EVOLUTION.

Vorlesungen über Deszendenztheorien mit besonderer Berücksichtigung der botanischen Seite der Frage. By Prof. J. P. Lotsy. Pp. vi+381–799. Theil ii. (Jena: Gustav Fischer, 1908.) Price 12 marks.

THE second part of Prof. Lotsy's book contains the substance of twenty-eight lectures, completing his course on evolution. Though making no claim to have broken new ground, the work is of real use. The presentation of contemporary knowledge of these subjects which it gives is comprehensive in scope and accurate in treatment. The author does not suffer from the delusion that in evolutionary science finality was reached fifty years ago, and it is a pleasure to see the results of modern research incorporated without ludicrous mistakes. This is probably the best text-book of the subject yet compiled.

There are occasional signs of vacillation between the old and the new conceptions. For example, as an instance of a dissimilarity between reciprocal crosses, Prof. Lotsy brings forward *Bilbergia nutans* × *vittata* on evidence which would have satisfied the older observers. Knowing the sources of ambiguity which affect such evidence, he remarks that possibly the dissimilarity may nevertheless be due merely to "Pleiotypie in F_1." Rather, until it shall have been ascertained by repeated experiment that there is consistent dissimilarity between the reciprocals, the presumption is strong that the differences observed are an expression of heterogeneity in the cross-bred generation as such, and are not dependent on the parental *rôles* allotted to the respective species. The break with tradition which Mendelian discovery has made is, indeed, so wide that a generation must pass before the older interpretations disappear, and evolutionists come to think easily and habitually in terms of the new system. This book will do a good deal towards accelerating the change.

To professed students of genetics this text-book may be recommended as bringing a quantity of fresh materials under consideration which have not previously been dealt with in a consecutive treatise. Of these materials some are ancient and some modern. For the first time, probably, Gärtner's work is presented in summary, and though, judged by modern standards, his experiments are fragmentary and imperfect, many readers will thus become aware of the range of observation which they covered. In another useful chapter a clear abstract of Nägeli's views is provided. Prominence is given to the remarkable experiments of Klebs on *Sempervivum Funkii* showing the influence of external conditions. Facts of this class are extraordinarily difficult to interpret, and until exhaustive work has been done on the same lines we must perhaps abstain from confident interpretation altogether. As a subject for genetic research the Sempervivums are most attractive. To turn over Jordan's plates of this polymorphic genus in the "Conspectus"—still more to see his actual collection of living plants now preserved in Miss Willmott's garden—is to realise the great possibilities which the material provides. It is to be hoped that someone will devote himself in good earnest to an analysis of those protean forms.

The book suffers from want of compression, and there are some repetitions. The long chapters on the geographical aspects of the problem serve rather to show how little help must be expected from that line of inquiry until much more minute treatment can be applied. No one supposes that any fresh lesson of importance is to be derived from the broad facts of geographical distribution, and the deductions that have been already drawn could, in so far as they are of consequence, be amply stated in half a dozen pages. On the other hand, as to the more interesting phenomena of geographical inter-relationship, the problems, for instance, of intergrading species, too little is said. In a text-book of this scope it would have been well to direct the attention of students to the necessity for thorough study of facts of this class, a field in which there is room for much analytical research.

There is one rather serious omission. The phenomena of regeneration and the mechanics of development are among the most obscure with which a theory of descent has to cope. In the minds of many evolutionists, the existence of those strange and specific powers of response to injury which modern research has revealed constitutes a formidable problem, and though for its solution we still wait, the facts should have been stated.

In dealing with matters of opinion, Prof. Lotsy shows good judgment and critical power. This is especially manifested in his discussion of adaptation, of the evidence for mutation, and of the assertions by which an attempt has been made to revive Lamarckian views. Sometimes, perhaps, one is conscious of an exaggerated patience. Conventional arguments which the author plainly recognises as bad are repeated out of deference to their originators. The expert is not in doubt as to his real opinion, but the lay reader will carry away the impression that decided questions are still open. When he deals with the writings of Wallace, indeed, he allows himself the remark that this is *"Selectionstheorie à outrance,"* but such freedom of expression is rare.

The author gives a full but somewhat non-committal account of the views of Eimer, and discusses the relation of Nägeli to the conception of orthogenesis as a main factor in evolution. Yet, after reading all that is said on this question, it is not easy to seize the exact point which is relied on as a proof of the reality of orthogenesis. The adaptation may be very perfect, and selection of indeterminate variations an unpromising account of the origin of that perfection, but it will never do to attribute this wonderful power of orthogenetic variation to organisms simply because we do not see how they could have become what they are without it. This, apparently, is Prof. Lotsy's view also, but many would have been glad of a more definite lead.

If the book reaches a second edition, as it probably will, the question of reducing it to two-thirds its present size should be considered. In that event also the proofs should be submitted to a professional proofreader, for in this second part, as in the first, the abundance of typographical slips exceeds all reasonable limits.

W. BATESON.

METALLOGRAPHY.

Introduction to Metallography. By Dr. Paul Goerens. Translated by Fred Ibbotson. Pp. x+214; illustrated. (London: Longmans, Green and Co., 1908.) Price 7*s.* 6*d.* net.

ALTHOUGH metallography is a very young science, a number of little books on it have already made their appearance, and of these Dr. Goerens's "Einfuhrung in die Metallographie" is not the least successful. The author says in his preface that before the publication of his work the numerous papers on the subject had not undergone systematic collection in Germany. If it is not the only book in this country, it is nevertheless welcome, and Mr. Ibbotson's excellent translation greatly increases its usefulness.

Alloys can be studied in several ways, of which the most important have been found to be the preparation of their cooling curves and the examination of polished and etched specimens under the microscope. The whole book is devoted to these two methods, and no reference is made to the electric and heat conductivity of metals and alloys, to their density, hardness, malleability, ductility, colour, resistance to shock, &c. No doubt this is due to the small amount of systematic investigation that has been devoted to these properties, but when a complete work on metallography is written these points cannot be entirely ignored.

However, the preparation of cooling curves by the use of thermocouples is adequately described by the author, and the various means of detecting critical points explained clearly. There is not much discussion of pyrometers, and the platinum resistance pyrometer, with which Heycock and Neville did their classical work, is not mentioned, presumably because it is not much used in Germany.

Physical mixtures, or bodies of perfectly uniform composition not governed by the laws of valency, are divided by Dr. Goerens into aqueous solutions, fused salts and alloys. He defends this use of the historical method on account of its expediency, observing that the reader will find out for himself as he proceeds that the division is arbitrary. The author, however, soon reaches the alloys, and thereafter for seventy-five pages gives a valuable account of the existing views on their constitution. This part is illustrated by descriptions of a number of series of binary alloys drawn from work on cooling curves done in England, Germany, and France, and the references are numerous and accurate. So many examples are given in each subdivision that it is a pity that here at least completeness was not attempted by including all the binary alloys which have been worked out. The additional space required in a second edition would not be great, and the author would produce a book of reference without destroying its usefulness as an introductory volume for students. There seems no reason to exclude even the mixtures of metals with oxygen, sulphur, arsenic, &c., many of which have been studied by Friedrich. These series of bodies are of higher importance to smelters than the alloys proper, and have been shown to obey the same laws when they are fused and allowed to cool.

The remainder of the book is devoted to the practical microscopy of metals and to an excellent and sufficiently full description of the iron-carbon alloys. The section is entitled "The Special Metallography of Iron and its Alloys," but no mention is made of any alloy of iron except those with carbon, so that for information as to all the special steels, which are now of so much interest, the reader must wait for another edition or another book.

Enough has been said to show that the standard work on metallography is yet to be written, but that students will find Dr. Goerens's book admirable as affording them a glimpse of the methods of investigating metals and alloys. T. K. R.

ELECTRO-THERAPEUTICS.

Röntgen Rays and Electro-therapeutics, with Chapters on Radium and Phototherapy. By Dr. M. K. Kassabian. Lippincott's New Medical Series. Pp. 545. (Philadelphia and London: J. B. Lippincott Co., n.d.) Price 15*s*. net.

WITHIN the last ten years the study of electrotherapeutics has rapidly grown, and, indeed, the progress has been so great that it is almost impossible for any author to record the constant advances published from day to day. Many valuable and important works have been published upon this subject, and when stating this, Dr. Kassabian says he wishes to present to his readers, clearly and concisely, the more important facts pertaining to electrotherapeutics and Röntgen rays.

The book begins with a general introduction, and considers the use of electricity in the medical curriculum. The following chapters are devoted to the nature and properties of magnetism and electricity, to different methods of producing electrical energy, and it should be said the apparatus required for the different forms have been very fully entered into. The next part of the work is devoted to pathological conditions in general diseases and special departments.

High frequency and, above all, as the title indicates, Röntgen rays occupy a very large part of the book, and the technique has been very carefully gone into. Though treating of this subject generally, the application of X-rays for diagnosis and treatment is fully described, and three chapters are devoted to the study of radium and phototherapy.

It will be seen from the very large number of subjects introduced that it must be a very difficult thing for any author to do justice to all in one volume. It can be said, however, that any student of electrotherapeutics carefully reading this book will find in it a valuable aid, and any practitioner desirous of obtaining an excellent general view of the subject will do well to obtain a copy. There can be no doubt whatever that the scope of the work has been carefully thought out, the descriptions and instructions are clear and concise, and Dr. Kassabian deserves to be congratulated heartily upon the general result. In addition to the printed matter, there are no fewer than 245 illustrations, many of them of great value, and all of considerable service to the student.

We have hinted in the above statement that the subject is so vast that it is difficult to do justice to every department, and the author seems to be conscious of this, because he admits that the space is all too brief for the study of phototherapy. The same might be said of the attention paid to the physiological effects of high-frequency currents. All the same, Dr. Kassabian has exercised a wise discretion, because in some parts of the book, such as the dosage of X-rays —a vexed question, and yet one of vital importance to the profession—he has given an excellent *résumé* of what has been done.

Now and again the author might confuse a beginner for want of a slight explanation; for example, at one time he points out (p. 448) that the X-rays may produce pigmentation of the skin, and, again, he quotes the case of a brunette losing pigmentation by the same agent.

The index, although excellent, might be improved. For example, "hypertrichosis" and "naevus" will not be found under the initial letter of each word, but under "X-rays" in these affections. Other examples might be quoted.

OUR BOOK SHELF.

On the Plantation, Cultivation and Curing of Parà India-rubber (Hevea brasiliensis), with an Account of its Introduction from the West to the Eastern Tropics. By H. A. Wickham. Pp. iv+78. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1908.) Price 3*s*. 6*d*. net.

MR. H. A. WICKHAM re-tells the interesting story of the successful effort of the Government of India with the aid of the Royal Gardens, Kew, to introduce the Parà rubber tree (*Hevea brasiliensis*) from Brazil to the eastern tropics. Though the tale, at least in outline, is fairly familiar, it is one that bears repeating, and as told by Mr. Wickham will, in spite of a certain ruggedness of style, be read with interest, since it has the advantage of being from the pen of one who can say with truth of the history he relates, *pars magna fui*.

The passages in which Mr. Wickham strives to impress on his readers his experience that the Parà rubber tree is properly a denizen of the immense forest-clad plains which occupy the areas between the great rivers of the Amazon system will attract attention. These plains are considerably more elevated than the flat ground which skirts the banks of the actual rivers, and is periodically inundated when the rivers rise. The tree does, indeed, occur on these low-lying tracts, but in Mr. Wickham's experience it does not thrive so well on these flooded levels as on the somewhat higher plateaux that abut upon them. The question is of interest because of the practical bearing it may have on the treatment of *Hevea brasiliensis* as a cultivated tree.

The discussion of the methods that, in the opinion of Mr. Wickham, are most suitable for the cultivation of the tree and the treatment of its latex will also be read with interest by those engaged in both occupations. The literature of the subject is already extensive, and much of it is of high quality. But what Mr. Wickham has to say will receive the attention of those practically interested in Hevea as coming from one who has had a long working experience of the problems involved, and one who possesses, what is quite unusual, an intimate acquaintance with the Parà rubber tree, both as a forest species and under cultivated conditions.

Decoration of Metal, Wood, Glass, &c. Edited by H. C. Standage. Pp. 228. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 8*s*. 6*d*. net.

THIS is described as a book for manufacturers, mechanics, painters, decorators, and all workmen in the fancy trades. It consists of a collection of recipes, such as are found in the well-known works of Spon and Cooley, but selected for use in the decorative treatment of various materials.

In the early sections the bronzing of iron, tin, zinc, alabaster, plaster of Paris, paper, and feathers is dealt with. Afterwards follow directions for such miscellaneous processes as the platinising of metals; plating with aluminium; the colouring of metals by immersion in chemicals; silvering and gilding; tinning and galvanising; the use of enamels and glazes; etching; varnishing, lacquering, and japanning. So far as can be judged from a recipe here and there, the methods seem to be trustworthy.

The book has no pretensions to being scientific, and it is necessarily, perhaps, more or less of a medley. Even so, the editing leaves something to be desired. The matter could have been better arranged and coordinated. Careless wording occasionally makes the meaning obscure or misleading. Thus the ingredients of a platinising solution (p. 25) include both ⅜ oz. of "ammonia chloride" and 3 oz. of "sal-ammoniac"; whilst no quantity is specified for the chief ingredient, platinum chloride. A chemist would readily see where the blunder lies; a "workman in the fancy trades" would probably be using "langwidge" long before he had found the proper correction. C. S.

Cast-Iron House Drainage, with Especial Reference to Town Houses. By G. J. G. Jensen. Pp. xii+206. (London: The Sanitary Publishing Co., Ltd., 1908.) Price 4*s*. 6*d*. net.

THE view is gaining ground in this country that it is often desirable to provide cast-iron drainage in lieu of the usual provision of stoneware pipes. The vibration from heavy motor traffic, underground railways, &c., is a circumstance which specially calls for this provision; and it is also possible to lay iron pipes and to join them in circumstances which involve delay and difficulty in the case of cement joints—such as during times of frost and in water-logged ground. The expense involved in repairs of stoneware drains must often exceed the initial increased cost (10 to 30 per cent.) involved in iron drainage, for the cast-iron drain, as the writer points out, is far more durable than the stoneware. This greater durability is mainly due to the longer lengths in which the iron pipes are manufactured, involving a very great reduction in the number of joints; a stoneware drain, for instance, thirty yards in length, will necessitate 45 joints, whereas in a similar length of iron drain there need only be ten. Moreover, the joints being made of molten lead are stronger and more trustworthy than the cement joints of the stoneware drain, and the iron drain is straighter and smoother in the interior. A further advantage possessed by cast-iron over stoneware drainage is the fact that the necessary bends, connections, and provision for inspection can be readily made to suit the special needs of any particular premises.

The advantages of iron drainage have been far more generally recognised in the United States of America than in this country, and the work under review is doing a good service in advocating a wider adoption of the safer method.

The general principles of sanitary drainage construction are also discussed in a very sound and practical manner; and the directions given throughout the book leave nothing to be desired on the score of clearness.

Macmillan's Orographical Map of Europe. Designed by B. B. Dickinson and A. W. Andrews. Size, 62 × 51 inches. (London: Macmillan and Co., Ltd., 1908.) Cloth, mounted on rollers, price 15*s*.

Notes on the Orographical Map of Europe. By the same authors. Pp. 30. Limp cloth, price 1*s*.

IN this excellent wall map the distribution of lowlands and highlands is shown by six different colours representing land below sea level, and that between the contours 0–600 feet, 600–1500 feet, 1500–3000 feet, 3000–6000 feet, and above 6000 feet. Ocean depths in fathoms are indicated by white and four shades of blue. The only names on the maps are printed very small, and are intended for the use of the teacher exclusively. The position of important towns is indicated by dots. These expedients have made it possible to produce a remarkably clear map on which the physical features of essential importance can be seen easily from every part of a class-room. In these days, when all good geographical teaching is based upon the broad principles of physical geography, an orographical wall map is an absolutely necessary accompaniment to every lesson, and teachers will welcome such a map designed by two competent authorities and produced in the best modern style at a moderate price.

The explanatory handbook provides valuable guidance as to how the map may be used most instructively.

Familiar Swiss Flowers. By F. E. Hulme. Pp. viii+224. (London: Cassell and Co., Ltd., 1908.) Price 7*s*. 6*d*. net.

THE title of the book makes it evident that it contains a selection of species, and is written for the *dilettante*. As the illustrations are the guiding and principal feature, the former is a necessity, and as to the second observation it is recognised that professed botanists are few, while the number of those sufficiently interested in flowers to learn their names is large. It will also be noted that Mr. Hulme is not treating of Alpine flowers only, although a number of these are naturally included.

The author's talent for depicting flowers is well known from the floral studies reproduced in "Familiar Wild Flowers" and other publications. The plates in the volume under notice bear evidence of his appreciation of the characteristic appearance and identity of the various specimens; the illustrations of the anemones and the white flowers are especially charming. The author has somewhat unnecessarily mingled the figures of plants that bear no relationship to one another, and has taken up valuable space with a few flowers that are too well known to require illustration; but the selection is generally wise, and the inclusion of many lowland plants should meet with approval. Sufficient information is given in the text to determine many species allied to those chosen for illustration.

At the present time of year, when so many tourists are contemplating a holiday in Switzerland, they will assuredly add to their pleasure by taking with them the means of identifying the flowers that appear to have a greater brilliancy in that country owing to their profusion, and this book, prepared with such a purpose, can be safely recommended.

Astronomischer Jahresbericht. Vol. ix. Pp. xxxv+653. (Berlin: Georg Reimer, 1908.) Price 21 marks.

WE are glad to direct attention to the ninth issue of this very valuable compilation, which is of great utility to all those who study astronomy, and by this time should have found its place in every observatory. The high standard has been thoroughly maintained, and the fact that the present volume is made up of 653 pages gives some idea of the quantity of material which has been dealt with. It may be mentioned, for the information of those who are not familiar with the previous annual volumes, that, in addition to the references to all the more important astronomical publications during the past year, a concise and accurate abstract of each research in question is given in nearly every case.

The importance of having such an abstract is obvious, for it enables the reader to become acquainted at once with the pith of the work described, and saves him probably much time and trouble, if he had had to procure the original work from a library and found that it did not contain the kind of information he was desirous of obtaining. There is no doubt that the compilation of such a volume as this involves strenuous labour on the part of those who bring this information together, and the least astronomers can do is to see that such an undertaking is not brought to an end by inadequate support on their side. W. J. S. L.

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 Crystallisation of Over-cooled Water.

IN order to show the over-cooling of water and to allow the free development of its crystals, I endeavoured to introduce in the over-cooled water a piece of ice put in a finely drawn-out glass tube. The experiment, carried out the first time by Mr. Michael Iwanow, gave an unexpected result; when the crystallisation reached the end of the tube, an ice-crystal having the shape of a hexagonal star, and very similar to the characteristic snow-crystals at this point, began to grow.

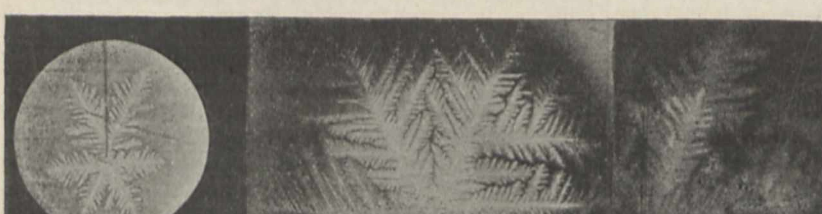

FIG. 1. FIG. 2. FIG. 3.

The greater the over-cooling of water the greater were the abundance of ramifications and the velocity of crystallisation. With water over-cooled to a temperature between $-0^{\circ}.3$ and -1° I obtained small stars (Fig. 1) with few narrow ramifications. The over-cooling to a temperature between -1° and -3° gave rise to stars with so densely developed ramifications that they resembled hexagonal plates (Fig. 2). The plane of stars contains the direction of the end of the tube, and therefore when this end is vertical a sufficiently large plate can divide the vessel in two parts. An over-cooling greater than to -3°—especially when the end of the tube is not narrow enough—produces several plates set in different azimuths, and the whole mass becomes at last a mixture of differently sized crystals and water, resembling the so-called "anchor-ice."

The crystals are often a conglomeration of several stars which have their planes, their principal rays, and even the ramifications of higher order parallel (Fig. 3).

When a star is broken the pieces of it rise horizontally in the water with slight oscillations and attain in such position the surface. This circumstance can explain the verticality of optic axis of river- and lake-ice.

The evolution of these artificial snow-crystals can be easily projected on a screen if the vessel with over-cooled water (a tumbler or an evaporating dish) be put into another vessel with plane-parallel sides containing water of a temperature somewhat higher than the thaw-temperature of the surrounding air. Any water will serve for over-cooling, but the refrigerating mixture (finely chopped ice upon which is poured a strong solution of NaCl) must not be too cold (from -4° to -6°), and its level must be lower than the level of the water which is to be over-cooled.

The projection is especially beautiful when the vessel is placed between two crossed Nicols (the photographs of Figs. 1–3 are taken in this way); on a dark ground grows a star, which gradually becomes more and more white, and at last—when thick enough (the thickness is generally of the order of a tenth of a millimetre)—obtains the colours of chromatic polarisation. It is easy to prove that these crystals are optically uniaxial, the tube being turned so long that the plane of a star is at right angles to the rays of polarised light, the image of the star disappears.

Precise measurements of these crystals are to be made in winter, when it will be possible to prolong their fugitive existence. The size of the stars depends—at a sufficient over-cooling, *e.g.* of -2°—principally on the dimensions of the vessel with over-cooled water; I often obtained single stars 8 cm. to 12 cm. broad. BORIS WEINBERG.

St. Petersburg, July.

Bright Meteors on August 19.

ON August 19 there was an unusual display of three bright meteors within about five minutes. The details were recorded here as under:—

h. m.		° °	° °	sec.	Radiant
9 40	>1	220+66	202+62	1·8	288+59
9 44	1	355+79½	283+70	1·0	56+60
9 45	[illegible]	269+ 9½	256+15½	2·0	320−15

The first was one of the *o* Draconids, the second a belated Perseid, the third a δ Capricornid. The Perseid was well observed, and it would be interesting to obtain a duplicate record of it.

W. F. DENNING.

Bristol, August 20.

Barisal Guns in Western Australia.

I HAVE just received the following note from Mr. H. L. Richardson, Hillsprings Station, 100 miles north-east of Carnarvon, on our west coast:—

"A peculiar incident happened here last evening (June 26) about an hour after sunset. In a south-easterly direction from here three reports took place high up in the air, and then a rushing noise like steam escaping, lasting for a few seconds, and gradually dying away. Mr. Loeffler, one of the owners of this station, was standing outside with me at the time. It was a beautifully clear evening, and there was nothing visible at all in that direction. The reports sounded like explosions of some combustible to which there was no resistance."

W. E. COOKE.

Perth Observatory, Western Australia, July 20.

SURVEYING FOR ARCHÆOLOGISTS.

I.

We have now two societies for the astronomical study of ancient monuments at work in Britain; a considerable number of the monuments have already been astronomically surveyed, with the result that the various alignments indicated have been shown to have been laid out to facilitate and utilise observations of the sun or stars.

It is not to be wondered at, therefore, that I have been repeatedly asked, now in one region, now in another, to put on paper some general hints to those who may feel inclined to take up the work so as to secure the necessary observations.

I think the first useful thing to say is that the inquiry is much less complex, and takes much less time in the measurement of any one monument, than is generally imagined; that the ideas involved are very simple, and do not go beyond the knowledge which should be possessed by everybody who wishes to enjoy and understand something of the world around him.

In the first place, the astronomical side of the inquiry, so far as the monuments are concerned, is very restricted. It has little to do with the various data concerning them which archæologists, with wonderful diligence, have now been accumulating for several centuries. The weight, shapes, size, colour and nature of the stones are not in question. All use of the spade for finding treasure or anything else is not in our province. If, when plans are given, the relation of the stones to each other is accurately given, we can accept them so far as the arrangement of the stones *inter se* is concerned.

One great advantage of being freed from the necessity of doing all this work is that would-be inquirers are saved the expenditure of a great deal of time and money; to them the spade is needless, because they deal only with the relation of the monument to the surrounding surface, and for the same reason the conditions of the stones themselves are indifferent to them.

What, then, is it they have to do? They have simply to determine, with an accuracy as great as can be achieved by the instruments at their disposal, the line of direction indicated by the lie of the stones in the various monuments. This problem is at its simplest in the case of the so-called "Avenues," such as those at Challacombe and Merrivale, on Dartmoor.

Do they lie east and west, or north and south, or in any other intermediate direction?

Again, take the cases of the so-called "outstanding" stones or tumuli so often met with at some distance outside the Cornish circles—those of the Merry Maidens and Tregaseal, to give instances; do they lie to the east, or the west, or the north or the south, or at some intermediate angle? and at what angle?

In the case of cromlechs or dolmens the matter is not quite so simple, except in the case of those furnished with an obvious outlook, an *allée ouverte* or *couverte*, to adopt the terms employed by French archæologists. I suppose there are hundreds of monuments of this class, of which so-called "plans" exist, but in spite of these plans, which may be quite good so far as the interrelation of the stones is concerned, we have no certain knowledge as to the exact direction in which these alley-ways or creeps point. The stones have been dealt with as stones, and their relations to their surroundings have been entirely neglected.

Fundamentally, then, to get out of this *impasse* it is a question of these directions in the first instance.

How is this to be done? It is here that the elements of knowledge of the things around us, which, I am thankful to say, now form part of the teaching in our best elementary schools, and which, therefore, are not of a very recondite nature, come in.

The ancient monuments, like everything else on the face of the earth or sea, appear to anyone who examines them close at hand to occupy the centre of a plane, which is really the little bit of the surface of the earth that we can see from any one point of view. This circular patch of land or sea is bounded in every direction by what is called the *horizon*, which is the most distant part of the land or sea from us, and on which the sky seems to rest. In the case of the sea, this horizon is level all round. In the case of the land, it may be high or low according to the surrounding conditions. If we live in a street it is high, its height depending upon the number of storeys in the opposite houses; if we are on the heights of Dartmoor it is very low, almost as low as a sea horizon, and as sensibly circular.

Suppose us, then, surrounded by this circular horizon, in front of an avenue; how, when we have measured the stones and plotted them at the proper distances apart, can we indicate the general direction of the lines of stones? We can divide the circle of the horizon, like all other circles, into 360°. But where—in what direction—are we to begin the numbering? Where must the zero be?

All mankind has now agreed for hundreds of years that the zero must be the *north* point; opposite to it is the *south* point, and the line joining these north and south points is called a *meridian line*.

This meridian line, passing along the earth's surface and joining the north and south points of the horizon, lies in a vertical plane passing through the point overhead called the *zenith*. The term meridian is used because the sun passes through this plane at the middle of each day. The line at right angles to the meridian line passes through two points on the horizon midway between north and south. These are called the east and west points, and in the four points now named we have the so-called *cardinal* points on the horizon.

The meridian so defined is called the *astronomical meridian*, and the cardinal points of the horizon involved are called astronomical or true.

The *astronomical* north and all the other points are absolutely stable; they never vary, and are always the same at all places. This north point may be roughly found at night, as it is the point of the horizon under the pole-star, the star which nearly occupies the centre of the circle round which the stars revolve in their daily apparent movement. The south point may be defined as the point of the horizon under the sun at noon.

Now all this seems plain sailing, but the trouble of it is that there are two north points and two meridians to be considered.

If we take a magnetic needle and balance it horizontally on a vertical pivot, its ends will be directed to two points on the horizon, which are not the same at all places with regard to the cardinal points. By drawing a great circle through these two points and the zenith point of the place, we obtain the plane of the *magnetic meridian*. The magnetic needle, as we see it in a pocket compass, has a marked N. end, and its length lies in and defines the magnetic meridian.

The *magnetic meridian line* is the intersection of the plane of the magnetic meridian with the plane of the horizon.

In Britain these two meridians do not coincide; at present, on the average, they form an angle with each other of some 18°. So that the magnetic north is 18° to the west of the true north.

The angle between the astronomical and magnetic meridian lines is called the magnetic *variation*, east or west according as the north end of the needle points to the west or east of true—that is, astronomical—north at any particular place at any particular time.

Such a needle is never at rest, as it is for ever under the influence of the magnetism of the earth, which is always varying. The north point it indicates, therefore, *varies* from year to year; hence the term *variation*; it also greatly varies from place to place, so that there is nothing stable about it; another difficulty is that there may be a local magnetic attraction, caused by iron in the underlying strata, or even gas or water pipes or iron railings, which interferes with the general magnetic attraction at the place, so that a reference to a *general* chart is insufficient.

In a survey of any kind, whether of stone monuments or houses and trees on an estate, to take instances, the first desideratum is a point of reference to which all measures must be referred; but the plan as a plan is incomplete unless the relation of the point of reference used to the astronomical north, or the magnetic north, point of the horizon is quite accurately shown.

Now, the reason that so many archæologists have dealt with the magnetic meridian and the magnetic north is that it is much more easy to determine it. Unfortunately, it has not struck them that their measures of angles, *so far as direction is concerned*, are useless unless the relation of the magnetic meridian to the astronomical meridian, at the monument under investigation and at the time of measurement, has been accurately determined.

It must be confessed that there is much excuse for them, for, until a few years ago, it was difficult in the absence of magnetic surveys to obtain this relation, which consists in an accurate statement of the angle called, as we have seen, the *variation* between the magnetic and astronomical meridians, or, in other words, the angle between the magnetic and astronomical north points of the horizon.

To give a concrete case of the facts, let us consider the case of the Nile Valley, where work such as we are now considering was begun by a Commission of the French Academy of Sciences in 1798.

They found that in 1798 a magnet swung along a line extending from a little to the west of Cairo to the second cataract had a variation of 11½° to the west. In 1844, when the great Lepsius, the prince of archæological surveyors, arrived on the scene to prepare his majestic plans of the temples, he found the west variation no longer 11½°, but 8½°. At the present time the variation is nearer 4° west. But, alas! in the modern British Schools and Institutes of archæology little attention is given, to judge from the data shown in the plans they publish, to the question which we are now considering. A notable proof of this may be gathered from the fact that, in spite of all the statements and plans that have been made lately concerning the newly explored temple at Deir-el-Bahari, I have been unable to learn whether the indicated direction of the axis of the temple is magnetic or true; the only information given me, oh! shade of Lepsius! is that the variation had not been determined by the surveyors.

It will be gathered from the above that when we may have to deal with such a large change of the variation in a century, an old plan with magnetic bearings but without the date of the actual observations is worse than useless. Even when the date is given, a reference to old Admiralty charts is necessary to get even an approximation to the value of the variation. This is one objection to the use of the magnetic meridian.

But, whatever has happened in the past, for the future British archæologists can hardly be excused from neglecting to compare the magnetic meridian they may use for their plotting with the true or astronomical meridian, and stating it on their plans.

Both the Admiralty and the Ordnance Survey have lately been busily employed in determining the magnetic variation over the British Isles, and in future it will be shown on every 1-inch Ordnance map, so that every archæologist, for the expenditure of one shilling, will be able to learn the present variation at any monument he may chance to be surveying. Indeed, it may be said that some of the old difficulties are now in a large measure solved.

The Admiralty have recently prepared a map showing this variation for the British Isles for last year, from which archæologists can learn approximately the value of the variation, and hence the direction of the true north, at any place.

But because most of the difficulties connected with the observations of magnetic bearings are disappearing, it is certain that the magnetic method will still continue to be largely employed, as it is the easier to work with.

It is not too early to emphasise the important fact that for the *astronomical* study of the various directions we want, for a reason I shall state later on, more than the angle from the north point, either magnetic or astronomical, generally termed the *azimuth*. We want the angular height of the horizon where the line of direction cuts it. This is called the *altitude*.

HOW AZIMUTH AND ALTITUDE ARE DEFINED AND READ.

Azimuths.

The Point Method.—A reference to the transactions of antiquarian societies will show that in the past the most commonly employed method of stating direction, or azimuth, has been by using a compass needle armed with a card such as is used by mariners, and hence called a mariner's compass. This, of course, gives us magnetic bearings.

In this the circle is divided into thirty-two parts, called points: four chief magnetic points, N., S., E., W.; four quadrantal points, N.E., S.E., S.W., and N.W.; and twenty-four intermediate points. If we take the N.E. quadrant, for example, the eight defining points are N., N. by E., N.N.E., N.E. by N., N.E., N.E. by E., E.N.E., E. by N. Now as these thirty-two points cover the 360° in the complete circle, each point contains 11° 15′, so that, reckoning directions in this way, there is a play of more than 10° for each statement made.

But the objection to this method of defining does not end here. If we read the bare statement that a cromlech, to take an instance, is open, say, to the N.E., one is apt to think that the true N.E. is intended; but where the variation is about 22°, as it is now in the west of Ireland, true N.E. is N.N.E. by compass, that is, two points more westerly.

This system of reckoning, then, besides being misleading, is too coarse for our purpose, so much so that even mariners are now giving it up, using degrees instead of points.

The Degree Method.—In the compass card so divided into degrees instead of points we may have 0 at both the N. and S. points (mag.), reading to 90° at the E. and W. points (mag.), or to 180° at the opposite point. Or, again, we may have 0° at the N. point (mag.), reading through the E., S., and W. points to 360°. Each mag. bearing is now defined quite independently of any quadrant, so mag. east would read N. 90° E., and mag. west N. 270° E.

The circles of small instruments are graduated to degrees, and so the azimuths are read to degrees and estimated to half degrees. In instruments with larger circles, whether it be a circular protractor for reading azimuths on maps, or a theodolite for determining them, the degree can be read to $\frac{1}{10}$th of a degree, or even more finely, by means of a device called a vernier, on which it is useful to dwell a little, as many regard it as of a recondite and mysterious nature and avoid it accordingly, whereas it is as simple as it is useful.

The vernier is a short scale, constructed so that its divisions are smaller by a definite and convenient amount than those of the scale with which it is used. In a very simple case this difference amounts to $\frac{1}{10}$th of a scale division, and the vernier is made so that its ten divisions are equal in length to nine of the primary scale. One extremity of the vernier scale is the reference point, or zero, and if this be coincident with a scale division, the remaining divisions of the vernier will be separated from divisions of the scale as indicated below:—

Division	0	of vernier	coincident with division of scale.		
,,	1	,,	falls $\frac{1}{10}$th short of division of scale.		
,,	2	,,	,, $\frac{2}{10}$ths	,,	,,
,,	3	,,	,, $\frac{3}{10}$ths	,,	,,
,,	4	,,	,, $\frac{4}{10}$ths	,,	,,
,,	5	,,	,, $\frac{5}{10}$ths	,,	,,
,,	6	,,	,, $\frac{6}{10}$ths	,,	,,
,,	7	,,	,, $\frac{7}{10}$ths	,,	,,
,,	8	,,	,, $\frac{8}{10}$ths	,,	,,
,,	9	,,	,, $\frac{9}{10}$ths	,,	,,
,,	10	,,	is coincident with		,,

If then the vernier be in such a position in relation to the scale that its fourth division is coincident with

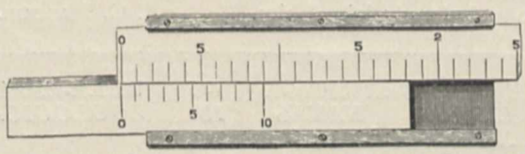

FIG. 1.—Model of a vernier showing how the divisions on a straight line can be divided into tenths. Here the vernier (below) has its zero point coincident with a division on the scale.

a scale division, the zero mark must be $\frac{4}{10}$ths removed from a scale division, and so on. In this way the coincidence of the vernier and scale divisions indicates the fractional part to be read.

It is quite easy to make a wooden model of a fixed scale and a sliding vernier; a little manipulation of this will make everything quite clear.

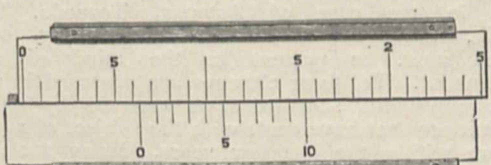

FIG. 2.—Here the zero of the vernier is between the 6th and 7th divisions of the scale. The third division of the vernier is coincident with a division of the line, so the reading is $6\frac{3}{10}$.

In a circle graduated to half degrees, the vernier is so constructed that its thirty divisions are equal in length to 29 divisions of the circle. The vernier divisions are therefore smaller than those of the circle by

$$\frac{1}{30} \times 30' = 1'$$

and the vernier is said to read to one minute. Thus to set the index of the vernier at the reading 30° 18', first adjust it to the position 30°; then move the index towards the mark corresponding to 31°, and stop when the eighteenth division of the vernier becomes coincident with a division of the scale.

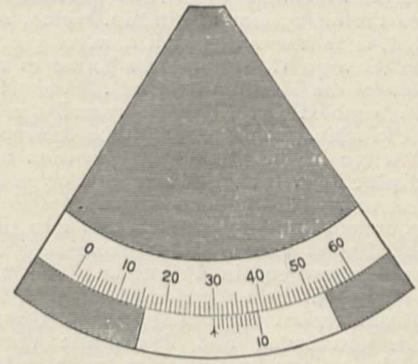

FIG. 3.—A vernier applied to a circle enabling azimuths (or any other angle) to be read to tenths of a degree.

So much, then, for the reckoning and readings of azimuth, measurements on a horizontal plane.

Altitudes.

For the reckoning of altitudes, which of course are observed with a vertical circle, the degree system is alone used, the fineness of the reading depending upon the size and graduation of the circle employed. The vertical circle is generally graduated into four quadrants of 90°, the zeros lying in the horizontal line. We can thus read elevations or depressions in degrees, or some smaller division of a degree.

NORMAN LOCKYER.

THE PERCY SLADEN TRUST EXPEDITION TO MELANESIA.

IN the autumn of last year the trustees of the Percy Sladen Memorial Fund made a grant to Dr. W. H. R. Rivers, F.R.S., of St. John's College, Cambridge, to enable him to make detailed sociological studies in the Pacific, and more particularly to study mother-right communities in the Solomon Islands, and to trace the details of the transition from mother-right to father-right. Dr. Rivers left England at the end of November, and, after staying a short time in the United States, proceeded to the Hawaiian Islands. Dr. Lewis H. Morgan, in his classical work, "Ancient Society," says (p. 403), "Among the Hawaiians and other Polynesian tribes there still exists in daily use a system of consanguinity which may be pronounced the oldest known among mankind. . . . It is the simplest, and therefore the oldest form, of the classificatory system."

The investigations of Dr. Rivers into the kinship systems of the two groups of Torres Straits islanders (Reports Camb. Exped. to Torres Straits, vols. v., vi.), and subsequent comparative studies led him to the conclusion that "as the Polynesian languages have arisen by simplification of those of the Melanesian family, so have the Polynesian kinship systems arisen by simplification of a variety resembling those found among Papuan and Melanesian peoples at the present time" (Rivers, "Anthropological Essays presented to E. B. Tylor," 1907, p. 314). In an essay (based on information obtained from natives by means of the genealogical method) which he has sent home, Dr. Rivers proves that his hypothesis was justified. He says, "The Hawaiians have lost nearly the whole of their old culture, and present from the point of view of the anthropologist a most depressing picture of the results of a century of contact with civilisation, and yet in the midst of the general wreckage there has persisted almost untouched the old system of kinship, which, so far as we can tell, is as it was fifty or a hundred years ago." The Niue (Savage I.) system was found to resemble closely that of the Hawaiian Islands. A short visit to Nukualofa enabled Dr. Rivers to record the Tongan system of kinship, which proved to be the representative of a stage in the process of transition in which certain distinctions, lost elsewhere in Polynesia, have been preserved. The Samoan kinship system proved to be anomalous, and falls much less into line with our knowledge of the mode of expressing relationships found elsewhere in Polynesia. The "godless Samoans," it will be remembered, differed in other respects from typical Polynesians; their Government was more patriarchal and democratic than monarchical; the village communities were quite independent and could dispossess their chiefs; there were no temples, altars, or offerings; there was a family cult of the animal god; in addition each individual has his tutelary god, as had the village.

Dr. Rivers spent nearly a month in Fiji, most of which time was devoted to the interior of Viti Levu; there he found an entirely new system of kinship of the most complicated and interesting kind, and quite different from the system previously recorded as the Fijian system; the latter is in vogue in the district dominated by Bau, though, so far as he could ascertain, it, with many minor modifications, is used by coast people generally. He elucidated the systems of some ten different tribes, showing variations of the two Fijian systems. It is rather surprising that such very considerable variations may exist in the kinship systems of people living close to one another, and differing in no way in general racial characters. Dr. Rivers is of opinion that the relationship terms of the mountain tribes must have had their origin in status relations rather than in those of kinship, and he suggests a comparison with the system of the Dieri of Australia.

Through the kindness of Bishop Wilson, Dr. Rivers was given a passage on the *Southern Cross* of the Melanesian Mission on her rounds from Auckland to the Solomon Islands. This enabled him to interview a large number of natives of various islands. He worked out fairly thoroughly the system of Raga (Arag, or Pentecost), which is by far the most complex one he has ever met or heard of; in fact, all the systems of the southern New Hebrides are so complex that he has come to look on such systems as those of Torres Straits as child's-play. The chief feature of the Raga system is that the same terms are used for certain grandparents and for certain relationships by marriage, while the mother's mother is called by the same name as an elder sister, just as in the inland systems of Fiji the father's father has the same name as the elder brother. A native of another island (who found it very amusing) told Dr. Rivers that the Raga people used to marry their granddaughters, and indeed he found that it used to be the custom in Raga for a man to marry the daughter of his brother's daughter. The Raga system also presents another set of complexities, which it shares with the system of Mota, one which puts the children of brother and sister in the relationship of parent and child. These features are all referable to the principle given by Codrington, which puts the sister's son on the same level as the uncle.

In the Solomon Islands, Dr. Rivers has obtained, so far, seven systems, which are all extremely simple in their general features, and he feels certain that they are really simplified and stand in much the same kind of relation to those further south, as the coast systems of Fiji stand to those of the interior. The three systems of Ngela, Bogotu, and northern Guadalcanar are on the same general lines, and many of the terms are exactly the same, and used in the same way, as those of the Bau system of Fiji. Those of Ulawa and Saa are of the most extraordinary simplicity, almost Polynesian in this respect. The whole set of systems seems to him to furnish beautiful evidence of the progressive simplification of kinship systems which accompanies progress in general culture. In every case Dr. Rivers has obtained a large body of evidence on kinship duties and taboos, &c., or their absence, all showing that the simplification of kinship systems goes with the disappearance of these duties and taboos. He has also obtained abundant evidence to show that the maternal descent in Melanesia does not in any way exclude a very thorough recognition of kinship through the father. All this work has been accomplished by the genealogical method, without which he could have done nothing in the time to which he would have attached any value.

The foregoing account will give an idea of some of the work already accomplished by Dr. Rivers; amongst other important results, not here alluded to, is a description of totemism in Fiji, which will be published in the September number of *Man*. In his last letter from Tulagi, dated May 8, Dr. Rivers was about to settle down in a definite district, probably in Rubiana, where he will make an exhaustive study of the natives, assisted by Dr. A. M. Hocart, of Exeter College, Oxford, and Mr. G. C. Wheeler, Martin White Student of the University of London, who had already joined him. A. C. HADDON.

THE PRESERVATION OF WELL-ESTABLISHED NAMES IN ZOOLOGICAL NOMENCLATURE.

AS was announced in NATURE of July 30, a discussion will take place in Section D of the British Association on the abuses resulting from the strict application of the rule of priority in zoological nomenclature and on the means of protecting well-established names.

Much inconvenience is caused by the extreme application of the rule of priority, the worst feature of which is not so much the bestowal of unknown names on well-known creatures as the transfer of names from one to another, as we have seen in the case of Astacus, Torpedo, Holothuria, Simia, Cynocephalus, and many others which must be present to the mind of every systematist. Yet these changes are proposed in order to comply with so-called laws enacted by various committees that have dealt with the subject of nomenclature within the last few years. Many zoologists think it is time to protest against the evil resulting from the indiscriminate application of what would be an excellent rule if tempered by a little consideration for tradition. Botanists at the Vienna Congress of 1905 have considered the same subject as regards the generic names of plants, and decided not to change such as have been universally used.

In anticipation of the discussion that is to take place at Dublin, the following memorandum has been circulated among British zoologists, and the signatures which are appended to it show that strict adherence to the rule of priority is far from meeting with general support, at least in this country.

The undersigned zoologists, whilst fully realising the justice and utility of the rule of priority in the choice of scientific names for animals, as first laid down by a committee of the British Association in 1842, wish to protest against the abuse to which it has been put as a result of the most recent codes of nomenclature, and consider that names which have had currency for a great number of years should, unless preoccupied, be retained in the sense in which they have been universally used. Considering the confusion that must result from the strict application of the rule of priority, they would welcome action leading to the adoption of a scheme by which such names as have received the sanction of general usage, and have been invariably employed by the masters of zoology in the past century, would be scheduled as unremovable.

(*Signed*)

E. Ray Lankester.	A. Günther.
A. Sedgwick.	J. C. Ewart.
P. Chalmers Mitchell.	d'Arcy W. Thompson.
Sydney J. Hickson.	Henry Woodward.
R. Bowdler Sharpe.	E. A. Minchin.
A. E. Shipley.	P. L. Sclater.
J. Arthur Thomson.	W. N. Parker.
Gilbert C. Bourne.	W. J. Sollas.
E. S. Goodrich.	Edward B. Poulton.
J. J. Lister.	Chas. O. Waterhouse.
W. C. McIntosh.	A. Smith Woodward.
F. Jeffrey Bell.	S. F. Harmer.
W. T. Calman.	W. Bateson.
W. E. Hoyle.	D. Sharp.
A. M. Norman.	J. Stanley Gardiner.
J. Graham Kerr.	G. A. Boulenger.

THE SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE visit of the British Association to South Africa in 1905 in many ways undoubtedly represented the high-water mark of scientific effort in the various colonies for some time to come. Three years ago the results of the commercial inflation consequent upon the war were only feebly foreshadowed, and Governments and people still hoped that the depression then beginning to loom would pass away. To-day no reasonable person questions that the colonies will, for a time, have to be run on a lower level, and unfortunately education and scientific endeavour have to be adapted to this standard. As regards association matters, Cape Town apparently exhausted itself in the 1905 effort, but now congratulates itself as the headquarters of the newly chartered Royal Society of South Africa. The Transvaal maintains its vigorous interest in the aims of the association, and has largely contributed to the success of the subsequent meetings, Kimberley in 1906, Natal in 1907, and the Grahamstown gathering just concluded.

The Grahamstown meetings, held at the Rhodes University College, were attended by about seventy visiting members, an encouraging number when one considers distances in South Africa. These, together with about one hundred local members and associates, served to justify fully the continuance of the annual gatherings of the association, and afforded that personal touch with fellow-workers so much needed by the comparatively isolated colonial man of science. The meetings were held under the presidency of Sir Walter Hely-Hutchinson, G.C.M.G., Governor and Commander-in-Chief of Cape Colony, and in his unavoidable absence, owing to Parliament being in session, his place was taken by Prof. S. Schönland, one of the vice-presidents of the association. The Governor's presidential address, which dealt mainly with the progress of scientific research in South Africa, was read by the Hon. Mr. Justice Graham, a grandson of the founder of Grahamstown.

Though Grahamstown was not deemed worthy to receive the British Association in 1905, a function reminiscent of the parent association was the first annual award of the South African medal and grant of 50*l*., raised in commemoration of the visit, "for achievement and promise in scientific research in South Africa." This was presented to Dr. Arnold Theiler, C.M.G., bacteriologist to the Transvaal Department of Agriculture, in recognition of his researches on animal diseases.

The meetings were divided into five sections, as follows:—Section A (mathematics, physics, astronomy, meteorology, and geography); president, Dr. Alex. W. Roberts; address, "Variable Star Research." Comparatively few papers were contributed to this section. Sections B and C (chemistry, metallurgy, geology, engineering, mining); president, Prof. E. H. L. Schwarz; address, "The Geological Discoveries of Economic Importance made by the Albany Pioneers." A dozen papers were offered on geological, mining, and engineering subjects. Section D (botany, zoology, agriculture, forestry, bacteriology, physiology); president, Prof. S. Schönland; address, "Some Aspects of Recent Progress in Pure and Applied Natural Science." This was the strongest section in contributions, the papers being mainly of zoological, botanical, and agricultural interest. Section E (education, psychology, history); president, Mr. E. G. Gane; address, "Tendencies in Modern Education." A special debate on native education took place in this section, the chief points of dispute being whether the native should be educated in the vernacular or the English language, and whether his education should be continued as far as university standards. About fifteen other papers dealt largely with different aspects of education. Section F (economics, archæology, ethnology); president, Mr. W. Hammond Tooke; address, "Notes on the Earlier Contributions to South African Anthropology." A dozen other papers were devoted mainly to anthropological subjects, and a demonstration of the ethnological exhibits in the Albany Museum was included.

The social functions included a reception by the Mayor and Corporation, receptions and entertainments by the various educational organisations of the city, visits to local institutions and places of interest, including a day at Port Alfred, and half a day at an ostrich farm. The evening popular lectures included one by Prof. G. E. Cory, on the history of the Eastern Province, and another by Dr. Theiler, on animal diseases in South Africa.

At the closing meeting of the council it was decided to hold the next (seventh) annual meeting of the association at Bloemfontein, under the presidency of the Governor of the Orange River Colony.

The annual meetings of the South African Ornithologists' Union were held conjointly with the meetings of the association, and were comparatively well attended. The president, Prof. J. E. Duerden, gave an address devoted to his researches upon the domesticated ostrich in South Africa, and several other papers on more orthodox ornithological subjects were contributed. At the business meeting a discussion took place as to the conduct of the Journal of the Union, when it was decided to issue a series of popular bulletins in addition to the Journal, with a view to encourage a wider interest in ornithological matters amongst sportsmen, farmers, and others.

J. E. DUERDEN.

Subjoined are extracts from the address prepared by Sir Walter Hely-Hutchinson, president of the South African Association:—

A remarkable advance has taken place in South Africa of late years in the matter of general public interest in scientific matters. Scientific men have taken an interest in, and have studied, South Africa for more than 150 years—La Caille, Le Vaillant, Herschel, Burchell, Lichtenstein, Andrew Smith, for example, are names which will be familiar to you, and will always be remembered in connection with early scientific inquiry and development in South Africa. But it is not so many years ago that scientific men were prone to be generally regarded in South Africa as an interesting class of persons who unselfishly devoted their lives to asking questions of nature, and to getting further conundrums for answers—amiable enthusiasts who actually worked, many of them, for nothing, read papers to each other on all sorts of abstruse subjects at the meetings of the Philosophical Society, and no doubt found out a great many interesting things, but were more or less outside the real and practical business of making a living. The general and commonplace view probably was, that when it came to dealing with the problems and difficulties of everyday life, your "practical man" was more likely to be successful, or more useful as an adviser, than the scientific man who was continually betraying an almost indecent curiosity about the secrets of nature, which, in some of its phases, might be regarded by many people as not wholly orthodox or reverent, and devoted his time and his intellect to the solution of questions which did not appear to have any practical bearing on the ordinary problems of life. By degrees, however, the practical value of scientific inquiry, and of scientific knowledge, became more generally apparent. Overlapping boundaries of farms, for instance, and consequent litigation, demonstrated the necessity of a scientific system of survey. Thousands of pounds have since been spent on the triangulation of the Cape Colony, and a secondary triangulation is in progress. The main triangulation has been extended throughout South Africa, and the work has been carried forward through Northern Rhodesia to Tanganyika in the shape of a geodetic survey which will in due course be prolonged to Cairo. With this great work the name of David Gill, the first president of this association, will always be honourably associated. The American inquiry into the causes of Texas fever, and the scientific demonstration of the fact that the disease was carried by ticks, led to the scientific investigation of the causes of the many other diseases which affect our flocks and herds in this country; and whereas twenty years ago there was no bacteriological laboratory in South Africa supported by public funds, now there are at least four. The most remarkable advance has been made in the matter of discovering the means of immunising domestic animals against the manifold diseases to which they are subject in this country, and the great progress which has been attained in ascertaining the true causes of these diseases promises to lead to the discovery, in time, of the means of immunisation against all of them. It is, indeed, in the matter of fighting disease, whether amongst animals or plants, that the practical application of the results of scientific study has made its utility evident to the mass, especially to the rural portion, of the population. The mining industry has always been a scientific industry; its successful development, whether on the mechanical or on the metallurgical side, has always evidently depended on the advancement of science in its own particular spheres; but to impress on a practically minded rural population the inestimable value to themselves, and to their pastoral and agricultural undertakings, of scientific research (costly and slow as it necessarily is, and always must be) has been a work of time, and has required many object-lessons.

Let me record some of the achievements of science, in this one matter of immunisation against disease, in the course of the last ten or twelve years. A practical and effectual means of stamping out rinderpest, and of immunising cattle which have been exposed to infection, has been found. Mules can be and are effectually immunised against horse-sickness, and there are good hopes of the early discovery of a practical method of immunising horses against that disease. Although it has not been as yet found possible to immunise stock artificially against east coast fever, the investigations which have been made into that disease have made it possible to recommend precautions, which have proved successful, for preventing the disease from making its appearance on a farm, and have demonstrated the possibility of clearing infected areas. A practical method of vaccination against biliary fever, which in donkeys, mules, and horses is stated to be a success, has been discovered. The possibility of producing a serum which is stated to have a strong preventive action in cases of heartwater in cattle, sheep, and goats has been demonstrated. Methods of inoculation against blue-tongue in sheep, which are likely to prove to be of considerable practical value, have been discovered. It is scarcely necessary that I should refer to the widespread confidence which is felt, by those interested in pastoral pursuits, in the vaccines against anthrax, quarter-evil, Cape red-water, and lung-sickness, which are issued from the various Government laboratories.

As regards diseases and insect pests of plants, the plague of the Dorthesia insect, which twenty years ago threatened to extinguish the cultivation of oranges in the Cape Colony, and led to the destruction of great numbers of blackwood trees and to the abandonment of that beautiful tree for street planting, was stopped in 1892 by the introduction of the Vedalia ladybird. The discovery of this remedy was due to the scientific study of insects. Fruit trees infected with scale insect can now be safely fumigated with hydrocyanic acid gas. This remedy is essentially the outcome of scientific inquiry. The continued cultivation of the vine, which was gravely threatened by the Phylloxera, has been made possible by the introduction of the method of grafting on "American stocks." This method, which is simple, has been developed by means of an infinite amount of close study and by innumerable scientifically conducted experiments. Study of the locust problem has shown how the great swarms of voetgangers, which cause such enormous destruction of crops, and even of grass, can be annihilated easily, and at relatively slight expense, by the adoptión of a method discovered and developed in South Africa. The entomologist, the chemist, and the engineer have amongst them solved the problem of the codlin moth, and it only remains for the horticulturist to apply effectually the knowledge which they have gained in order materially to reduce, or even to get rid of, the ravages of that pest of our apple orchards. There is promise that the destructive mealie-borer may prove to be controllable by simple means. This problem, as well as the problem of the fruit fly, is now being investigated in the Government laboratory at Grahamstown; and it does not seem too much to hope that before many years have elapsed the scientific plant-breeder will have succeeded in evolving varieties of wheat and oats which will fully resist rust, whilst proving quite satisfactory in other respects.

Vast strides in the matter of the study of the hybridisation of plants, and in the selection and fixing of characters of varieties, have been made during the last few years by the application of new theories of the transmission of characters, theories which were first formulated more than forty years ago by Gregor Mendel to explain the results which he obtained in crossing varieties of the sweet-pea in his monastery garden. Mendel published the result of his work in 1865, but until 1901 it appears to have been completely lost to view. Probably the good Abbot little realised the profound importance of his deductions as regards the realm of practical agriculture. Hybridising used to be described as a game of chance, played between man and plants, in which the chances were in favour of the plants. Mendel's work changed the whole aspect of the problem. His discovery, that in cross-breds the egg-cells and pollen-grains are pure with respect to the characters which they individually carry, explains many facts which were previously mysterious, disturbs the foundations of many current theories of heredity, and indicates the possibility of picking out the valuable characters from different varieties and of building up an ideal type within a reasonable time. It is on these lines that, as I understand, the Transvaal plant-pathologist is now working in his endeavours to produce rust-resisting wheats suitable to South Africa.

The value, even of the results hitherto obtained (and they are few in comparison with the results which it is yet hoped to obtain), is really beyond estimate. That the high importance of scientific inquiry is now generally recognised in South Africa is demonstrated, not only by the confidence which is now shown throughout the country in the men who have obtained the results to which I have referred, but by the establishment and flourishing growth in South Africa of our own Association for the Advancement of Science, which includes in its ranks not only men who have made some branch of science their life-study, but many who, like myself, cannot pretend to the possession of accurate scientific knowledge, but are deeply impressed with the value to this community of the promotion of scientific inquiry and research.

I have dwelt at length on the subject of the efforts of science in the matter of combating disease because it is an aspect of the question of the advancement of science which more particularly and immediately affects the practical interests of the majority of the South African community. To survey the whole field would be impossible within the available limits of time, and without exhausting the patience of my audience, even if my acquaintance with the various subjects were sufficient to justify me in dwelling on them. I should like, however, to bear my testimony to the unselfish devotion to the cause of science which is customarily shown by scientific workers in South Africa, in whatever branch of science they may be interested. In these days of scrambling after fortune, the unrewarded or scantily rewarded efforts of men searching after scientific truth with the "obstinate humility which is the crown of genius" should compel our respect, our admiration, and our material, no less than our moral, support.

I say material support, for however unselfish scientific inquirers as a class may be, however ready to devote themselves to their work without special pecuniary reward, they are not, as a rule, men of private means, and it is necessary that they should at least be provided with a sufficiency of bread and butter. Scientific research is necessarily slow. It may be years before any particular line of inquiry leads to a practical result. Long and costly inquiries, such as Koch's inquiry into east coast fever, may even have only a negative result. If, therefore, scientific research is to be pursued in South Africa in the thorough manner in which it ought to be pursued, it should be endowed in some form or other. Such endowment may come either from public sources, so that all the tax-payers contribute to it, or from private sources. It is not for me to prescribe or to suggest from which source it should come. I merely indicate the necessity. I would not, however, wish it to be understood that the South African Governments have neglected their duty in the matter of promotion of scientific research. Far from it. In Cape Colony, the Grahamstown Laboratory, where much useful work was done by Edington, was established seventeen years ago, and has since been considerably enlarged. A laboratory and experimental station, in which Lounsbury carried out those remarkable investigations which proved that the Bont tick was the carrier of heart-water, and arrived at other exceedingly valuable and interesting scientific deductions, has been established at Rosebank. The Natal Government has established a laboratory near Maritzburg, at and in connection with which Watkins Pitchford and his assistants have done much useful work, notably by making the discovery that horses could be protected against horse-sickness by the exclusion of biting insects, and in the preparation of anti-toxic sera and of anti-venene; and the Transvaal Government, after liberally subsidising Theiler's epoch-making investigations, has recently built an experimental station, at a cost of some 60,000*l.*, which will bear comparison, so far as design and facilities go, with any such station in the world. Added to this, the Cape Government, besides incurring large expenditure on rinderpest experiments, contributed liberally to defray the out-of-pocket expenses of Beattie's magnetic survey, expended large sums on Gilchrist's investigation of South African marine biology, and joined with the other South African Governments in defraying the heavy cost of Koch's inquiry into east coast fever; and the Zululand Government bore the whole of the expense of Bruce's nagana investigations. It cannot be said, therefore, that the South African Governments have been backward in this matter. Much has been done, no doubt, but more is wanted.

It is not only in connection with the investigation of diseases that research is required. It is, no doubt, the practical value of that particular line of research which has contributed in a large degree to the popularisation in South Africa of the advancement of science. But it is the educative side of scientific research that will in the end prove of the highest and most permanent value to the community. That fact has been recognised by the Transvaal Government, which has provided, in its new experimental station, for the training of students, and a small commencement has been made in the matter of training research students in the laboratories of some of the colleges in Cape Colony.

NOTES.

WE notice with deep regret the announcement of the death of Prof. Henri Becquerel at the age of fifty-six.

AN international congress is to be held at the photographic exhibition which is being arranged to take place at Kiev from December 15, 1908, to January 15, 1909.

DR. ERIC A. NOBBS, agricultural assistant to the Cape Government, has been appointed director of agriculture in Rhodesia.

LIEUT.-COLONEL BOURGEOIS, chief of the geodetic section of the French Army Geographical Service, has been appointed professor of astronomy and geodesy in the Paris École polytechnique in succession to M. Poincaré, who has resigned.

THE herbarium formed by Mr. Duthie, and hitherto quartered at Saharanpur, has been transferred to the Imperial Forest Institute, Dehra Dun; any correspondence in connection with it should be addressed to the Imperial forest botanist of that institute.

DR. W. H. WILLCOX, lecturer on public health, pathological chemistry, and forensic medicine at St. Mary's Hospital Medical School, has been appointed senior scientific analyst to the Home Office in succession to the late Sir Thomas Stevenson.

THE British committee of the first International Congress of the Refrigerating Industries (Congrès international du Froid), to be held in Paris on October 5–12, at the Sorbonne, has issued a programme of British papers and resolutions to be brought before the congress. The various sections and the presidents are as follows:—I. Low Temperatures and their General Effects, Prof. d'Arsonval; II. Refrigerating Appliances, Prof. H. Léauté; III. The Application of Refrigeration to Food, M. A. Gautier; IV. The Application of Refrigeration to other Industries, M. E. Tisserand; V. Application of Refrigeration in Commerce and Transport, M. Levasseur; VI. Legislation, M. J. Cruppi. Lectures will be given by Prof. von Linde on refrigeration in dwelling places, and Prof. d'Arsonval on liquid air and very low temperatures. Further particulars can be obtained from the secretary of the British committee of the congress, 3 Oxford Court, Cannon Street, London, E.C.

A COMMITTEE is being formed to erect a monument to the late Prof. K. von Than, of the University of Vienna, whose death was announced recently. The monument will be set up at Ó-Beese, in Hungary, where Prof. von Than was born.

THE Oklahoma constitution contains a provision making it obligatory upon the legislature to establish a geological survey. The first State legislature passed a law placing the survey under the control of a commission consisting of the governor, the State superintendent of public instruction, and the president of the State University. We learn from *Science* that the sum of 3000*l*. was voted for the work, and that the commission has now elected Dr. Charles N. Gould, head of the department of geology in the State University of Oklahoma, to be director of the survey. Dr. Gould has been instructed to report on the building stone, road material, and oil and gas of the State.

DR. E. F. ARMSTRONG, Recorder of Section B (Chemistry) of the British Association, informs us that the following papers have been promised in addition to those already announced (July 30, p. 299):—the liquefaction of helium, Prof. Kamerlingh Onnes; anticipations and experiments on the liquefaction of helium, Sir James Dewar, F.R.S.; note on a volatile compound of cobalt with carbon monoxide, Dr. Ludwig Mond, F.R.S., and others. We are also informed that additional papers to be read in Section G (Engineering) are:—a clock-driving mechanism for equatorial telescopes, Sir Howard Grubb, F.R.S.; experiments on rotating discs, J. Brown, F.R.S., and M. F. Fitzgerald; strength of solid round-ended columns, W. E. Lilly; the study of breakages, W. Rosenhain.

As announced already, the autumn meeting of the Iron and Steel Institute will be held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell, Bart. The following are among the subjects of papers offered for reading:—scientific control of fuel supply, Prof. H. E. Armstrong, F.R.S.; metallurgy at the Franco-British Exhibition, H. Bauerman; gas-producer practice, Prof. W. A. Bone, F.R.S., and Dr. R. V. Wheeler; the constitution of carbon steels, Prof. E. D. Campbell; the freezing point of iron, Prof. H. C. H. Carpenter; the production of finished iron sheets and tubes in one operation, S. O. Cowper-Coles; the chemical control of the basic open-hearth process, A. Harrison and Dr. R. V. Wheeler; the influence of silicon on the physical and chemical properties of pig iron, A. Jouve; analysis and synthesis in the foundry, J. E. Stead, F.R.S., and T. Westgarth.

ACCORDING to a *Times* correspondent, Dr. Lee De Forest expects that within two years Paris and New York will be in direct wireless telephonic communication. An apparatus which may ultimately transmit and receive messages to and from the Eiffel Tower is to be installed upon the 700-feet tower of the Metropolitan Life Insurance Company of New York. It is reported that Dr. De Forest estimates the radius of his apparatus, when installed at an adequate height, to be about 1000 miles, but he is now working at certain improvements which he thinks will make possible Transatlantic communication. The installation on the Metropolitan tower will probably be ready by the end of the year, and the first object will be to send bulletins to ships equipped with the radio-telephonic and telegraphic apparatus. Dr. De Forest says that the length of the wire which he means to install will admit of the employment of a wave of a length long enough to be inaudible by any ordinary apparatus unless specially tuned to catch it. It is also reported by the *Times* that communication has been established by wireless telephony between the Eiffel Tower and the Pointe Duraz, on the coast of Brittany, south of Brest, a distance of more than 500 kilometres. The transmitter used at the Eiffel Tower consists of a Poulsen singing arc producing more than a million waves a second. The receiving apparatus includes the usual aërial wire and Captain Ferrée's electrolytic detector.

IN the *National Geographic Magazine* for August, Mr. L. G. Blackman, principal of Alluolani College, Honolulu, describes an ambitious scheme for the organisation of the Pacific Scientific Institution in that island, which has for its object the investigation of the Pacific Ocean, "the most explored and least known region of the globe." It is proposed to dispatch from this centre parties of trained explorers in a specially equipped vessel to the various island groups. The programme includes the collection of anthropological data; the languages, religions, laws, mythologies, legends, and genealogies will be recorded; technology, arts, and medicine will be studied; series of mammals, birds, reptiles, and botanical specimens will be collected; the coral reefs, marine fauna and flora, ocean currents, geology, and meteorology will be investigated. The survey, it is estimated, will occupy fifteen years, at the end of which reports will be issued, and progress bulletins will be published periodically. The scheme also provides for the establishment of a central museum, zoological garden, and marine biological station. Mr. Blackman, in conclusion, states that "the manner in which the institution has been incorporated and the trustees under whose administration it has been placed assure us that the long-delayed work of Pacific exploration will shortly be commenced." The increasing interest of America in the future of the Pacific will doubtless encourage her to detail for this work the many trained explorers at her disposal. The results of this important scientific survey will be awaited with interest.

A RECENT issue of *Science* contains particulars of the appropriations for the U.S. Department of Agriculture for the ensuing year. The grand total of grants amounts to 3,132,021*l*., which is an apparent increase over the previous year of 480,163*l*., or about 15 per cent. A large part of this increase, however, is only nominal, since for the present year more than 200,000*l*., derived from receipts from forest reserves, is available. The net increase is distributed through all sections of the department, and notably larger sums are available for the management of the national forests, the pure food and drug inspection, the campaign against the gipsy moth and cattle tick, and for additional buildings and equipment on the forest reserves and for the Weather Bureau. Provision is made for new investigations, and among these may be mentioned the inauguration of evaporation investigations and of studies of the prevalence and extent of tuberculosis among dairy cattle, the inspection of foods intended for export under certain conditions, and the manufacture of denatured alcohol in small amounts under farm conditions. Among the appropriations, we notice 14,000*l*. for purchasing, fencing, &c., some 12,800 acres of the Flathead Indian Reservation in Montana for a permanent national bison range, for a herd of bison to be presented by the American Bison Society. The Weather Bureau is to receive 332,452*l*., an increase of 49,744*l*. Of this amount, 12,000*l*. is for the erection of a main observatory building at Mount Weather, Va., to replace that destroyed by fire on October 23, 1907. The Bureau of Animal Industry is to benefit by 216,172*l*., an increase over last year of 9660*l*. The emergency appropriation for the eradication of the cattle tick in the south is increased from 30,000*l*. to 50,000*l*. The Bureau of Plant Industry receives an apparent net increase of 57,900*l*., and the Bureau of Chemistry an increase of 25,760*l*., chiefly for additional expenses incident on the enforcement of the National Food and Drug Act.

The appropriation for the Bureau of Soils is increased to 46,940*l.*, that of Entomology to 36,992*l.*, while the total appropriation for the Office of Experiment Stations is 206,924*l.*, an increase of 4280*l.*

ACCORDING to the report for 1907, the Albany Museum, Cape Colony, continues to make steady progress, but the congested condition of the collections, owing to insufficient accommodation, necessarily tends to hinder expansion. By the death of Mrs. George White, of Brakkloof, near Grahamstown, the museum has lost a liberal and constant benefactor.

IN vol. xvii., part v., of the Proceedings of the Royal Physical Society of Edinburgh, Prof. J. A. Thomson records from the Færoes a large antipatharian coral hitherto unknown from the British area, and provisionally identified with a well-known Mediterranean species, which has been stated to occur in the Bay of Biscay. The single Færoe specimen, which is more than a yard in height, was dredged up by a fisherman.

FROM the author, Mr. M. Doello-Jurado, we have received a copy of an "Essai d'une Division Biologique," extracted from *Annales de la Sociedad Cientifica Argentina*, vol. lxv., pp. 189 *et seq.*, 1908. In this it is proposed to divide vertebrates into two main groups, according to their mode of fecundation. In the one group fertilisation of the ovum takes place within the body of the female parent, while in the other this process is external. "Vertébrés à fecondation interne" are further divided into an oviparous and a viviparous subgroup.

IN the double July and August number of *Naturen*, "J. G." records the capture of a specimen of Sowerby's beaked whale (*Mesoplodon bidens*) at Bergen. These cetaceans seem much less uncommon on the coasts of Norway than on our own shores, three specimens having, to our own knowledge, been taken at Bergen during the last few years. The new specimen is unusually small, and probably, therefore, immature, its length being only 2·45 metres, whereas normally adult examples attain about double this length.

To Mr. B. B. Woodward we are indebted for a separate copy of his presidential address delivered before the Malacological Society in February last, and published in vol. viii., part ii., of the society's Proceedings. The title is "Malacology *versus* Palæoconchology," and attention is specially directed towards an alleged lack of harmony existing between the works of students of recent and of fossil Mollusca. Workers in the existing group are accordingly asked to check their results by a comparison of the labours of palæontologists, while the latter are urged to desist from the practice of brigading together groups which have been shown by the former to have no near relationship. A useful table of the time-distribution of the leading molluscan groups is appended.

To the August number of *British Birds*, Mr. C. B. Ticehurst contributes the results of an inquiry into the recent outbreak of wood-pigeon diphtheria, of which the distribution is illustrated by a map. The disease, it appears, has been familiar to sportsmen and gamekeepers for some years as being liable to occur in seasons when acorns and beech-mast are abundant, but its true cause was unknown. The disease was in the main confined to the Thames valley area, and appears to have been most prevalent among the migratory birds which arrived in autumn from the Continent. It is suggested that the contagion was communicated by one bird swallowing food that had been coughed up from the gullet of another. The course of the malady may be either rapid or lingering. The active cause of the disease is the presence in the mucous membrane of the throat of a bacillus believed to be specifically distinct from the one which causes diphtheria in the human subject.

THE second part of vol. xci. of *Zeitschrift für wissenschaftliche Zoologie* contains a very detailed account of the minute structure of the eyes—compound and simple—of the fresh-water crustacean *Apus productus*, by Dr. W. Wenke, of the Zoological Institute, Berlin. The investigation was taken up as a further development of Hesse's "Untersuchungen über die Organe der Lichtemfindung bei niederen Thiere." Without entering into the results of the investigation, attention may be directed to the elaborate nature of the text-figures illustrating the histology of the compound eyes. Incidentally, it may be mentioned that *Apus productus* seems to be as capricious in its appearance as the British *A. cancriformis*. In 1901 females were, for instance, abundant in the neighbourhood of Berlin, but for several years afterwards the author could obtain no other specimens until he found the species common at Fürstenbrunn in 1906 and 1907. Owing to the cold spring the species at that place has this year attained only two-thirds its normal size.

FEW food problems are more important than the development of bacteria in milk, and the dairy farmer is fast recognising that micro-organisms are the cause of many of his troubles. Elaborate apparatus has been devised for cooling, pasteurising, and sterilising milk, and is being used to a large and increasing extent in modern dairies. Bulletin No. 111 of West Virginia University Agricultural Experiment Station gives a full description, with illustrations, of some of the methods used in America, and will prove very useful to those interested in the technical side of bacteriology.

AN interesting batch of bulletins has reached us from the Agricultural Experiment Station of the Purdue University (Indiana, U.S.A.), some dealing with local practical problems and others of more general interest. In No. 119 is given a list of the plant diseases occurring in the State for the year 1906, with an indication of their relative prevalence. The basis for the estimation of losses and the distribution of the diseases was a large number of reports furnished by correspondents all over the State. The value of such a list, both from the scientific and the economic point of view, is obvious, and some of our agricultural institutions would do well to draw up similar lists for the areas they serve.

A NUMBER of the "Progressus Rei Botanicæ," prepared by Dr. J. W. Moll, and published for the International Association of Botanists, is devoted to the review of the progress in microscopic technique since the year 1870. With regard to the microscope and its component parts, water immersion objectives were already in use prior to that date, but oil immersion objectives are innovations and apochromatic lenses are more modern. The author regards the Abbé condenser and revolving nose-pieces as the most practically useful devices that have been introduced. Allusion is made to the investigation of ultra-microscopic particles and microphotography with ultra-violet light, but more information would have been acceptable. A discussion is presented of the opinions held with regard to the value of fixing and staining methods, in which Dr. Moll disagrees in the main with Fischer's criticisms. It is noted that the method for preparing paraffin sections in ribands was first announced by F. Spee in 1885. Reference is made to certain physical tests, of which De Vries's plasmolytic method is the best known.

THE failure of Scots pine when planted on farm lands has been so pronounced in many parts of the Continent that the matter was referred to Prof. Albert for investigation. Mr. B. Rippentrop furnishes an account of the work, so far as it has gone, to the Transactions of the Royal Scottish Arboricultural Society (vol. xxi., part ii.). There is no difficulty in connecting the failure with the fungus *Polyporus annosus*, but the question remains whether the fungus is the primary cause of the disease. On forest lands, although the Polyporus is present, the trees do not suffer, and it appears that the difference lies in the physical condition of the soil. On farm lands it was observed that nearly all the trees showed disease of the roots, and it is inferred that when the trees are thus weakened they fall a prey to the fungus. The interplanting of hard-wood trees, notably of species of Acacia, leads to an improvement of the soil by which the conifers are benefited.

THE Upper Gila and Salt River valleys of Arizona and New Mexico, the antiquities of which are the subject of a monograph by Mr. Walter Hough in the thirty-fifth Bulletin of the Bureau of American Ethnology, form part of the States of south-eastern Arizona and south-western New Mexico, close to the southern boundary of the Republic. This region at one time provided a home for numerous hunting and pastoral tribes, some inhabiting the higher forest belt, which now constitutes the greatest virgin forest remaining in the United States, others cultivating the fertile valleys watered by the streams which descend from the higher ridges. The abundant remains of cliff dwellings, pueblos, and the cemeteries in which the inhabitants buried their dead, prove that this country was at one time thickly peopled. When and why they disappeared is not known; it was certainly prior to the famous exploration by Francisco Vasquez Coronado in 1540. Large collections of their pottery, clothing, and other manufactures have been made from the numerous cliff dwellings and pueblos which sheltered this now forgotten race. Everything indicates that they had attained a fairly high culture. They must have been able to combine in the construction of works of national importance, as, for instance, in building the gigantic irrigation dam in the Animas valley, New Mexico, an earthwork 5½ miles long and from 22 feet to 24 feet high. Of their language we know as little as of their history, the petroglyphs on smooth rock surfaces showing only rude figures of men and animals, with various symbols which have up to the present defied interpretation. Mr. Hough's report is a good example of the careful work performed by the Bureau of Ethnology.

THE latest additions to the useful and compact series of "Manueli Hoepli" are a volume by Lanfranco Mario on frauds in electrical meters ("Le frodi nei misuratori ellettrici"), and one by Prof. Vincenzo Reina, the indefatigable treasurer of the recent Mathematical Congress, on optical instruments ("Teoria degli Strumenti diottrici") (Milan: Ulrico Hoepli, 1908, prices 4.50 and 3 lire respectively). Dr. Lanfranco deals with the problem of "sealing" sources of electrical energy in connection with the Italian Government duty on electric power, and his book treats generally of the question of fraud in the working of electric meters, or in connection with the so-called sealing in question, as well as its means of prevention. Prof. Reina's handbook may be described as an elementary treatise on geometrical optics; it deals with the laws of refraction, the relations between conjugate foci in a system of coaxial lenses and such instruments as the compound microscope, telescope, and telephotographic lens. The author's treatment of the subject is simple in character, and does not include elaborate discussions of aberrational and other errors.

WE have received the "Atti della Società italiana per il Progresso delle Scienze," a society which was recently founded on lines similar to the British Association and other organisations of the same kind, and held its first annual meeting in Parma on September 23–28, 1907. The association includes the following sections:—(1) mathematics, astronomy, geodesy; (2) physics, geophysics, meteorology; (3) mechanics, engineering, electrotechnics; (4) chemistry; (5) botany; (6) geography; (7) mineralogy, geology, palæontology; (8) botany; (9) zoology and comparative anatomy; (10) anthropology; (11) anatomy; (12) physiology; (13) pathology and bacteriology; (14) economics and statistics. The present volume contains a summary of the proceedings, together with reports *in extenso* of the inaugural addresses by the Mayor of Parma, Prof. Vito Volterra, president of the association, and the Minister of Public Instruction; the general lectures by Prof. G. Ciamician on organic chemistry in organisms; by Prof. P. Foà, on the biological significance of tumours; by Prof. M. Pantaleoni, a kinematographic view of progress in economic science, 1870–1907; and sectional addresses by Profs. V. Cerruti, A. Righi, L. Luiggi, M. Ascoli, E. Paternò, G. Cuboni, G. dalla Vedova, A. Issel, A. Borzì, A. Andres, G. Sergi, G. Fano. The next meeting will take place in Florence in September of this year.

WE have received the report for 1907 of the Liverpool Observatory maintained at Bidston (Birkenhead) in the interest of shipping by the Mersey Docks and Harbour Board. A signal gun is fired daily at 1h. p.m., and chronometers, sextants, and other apparatus are tested for shipmasters. The meteorological observations are very complete, and include indications from Dines's, Osler's, and Robinson's anemometers. The daily meteorological results show the extreme and mean values, the amount and duration of rain, and the number of hours that the wind blew from each of eight points of the compass. The absolute maximum temperature of the year was 76°·0, in July, and the minimum 20°·4, in January: the mean for the year was 0°·7 below the average. The rainfall was 26·57 inches, practically 2 inches below the average; rain was recorded on 209 days. Among other useful work performed we note that reports are supplied daily to the Meteorological Office for the preparation of its weather forecasts. Some details connected with the records of a Milne seismometer are included in the observatory report.

THE University of Illinois Engineering Experiment Station has recently issued Bulletin No. 23, "Voids, Settlement and Weight of Crushed Stone," by Mr. Ira O. Baker. This bulletin gives the results of some experiments to determine the proportion of voids in crushed stone loaded by various methods in cars and in waggons, to find the amount of settlement during transportation in waggons and in cars, and also to obtain the relation between the weight of a unit of volume of the solid stone and that of the same volume of crushed stone immediately after being loaded in various ways into cars and waggons, and also after being transported different distances. Copies of this bulletin may be obtained gratis upon application to the director, Engineering Experiment Station, Urbana, Illinois.

AN article on "England's Neglect of Mathematics," contributed by Prof. G. H. Bryan, F.R.S., to the August number of the *Cornhill Magazine*, should do something to awake the British nation to a sense of its duties to science.

A number of instances are given of the value of mathematical research, and a plea is made for greater encouragement for mathematicians and more serious work in higher education. For example, as Prof. Bryan points out, "Before the mathematical theory of stability had been developed many ships were sunk and many lives lost which could have been saved if the problem had been properly placed in the hands of the mathematician. It was only after these losses took place that the theory of the metacentre was finally evolved, and the problem of stability was reduced to one of pure arithmetical calculation. If one-tenth of the money expended in building these ill-fated ships had been offered to a really competent mathematician possessing the highest knowledge of his subject, to enable him to devote his whole time for a year or so to this particular problem, the saving to the community would have been immense. Yet a similar drama may be enacted at the present day in connection with artificial flight, for while the mathematical theory of stability has been outlined there is a great deal of work to be done before the results can be reduced to simple practical rules."

A FORM of cadmium cell suitable for supplying a small current much more constant than can be obtained from a storage cell is described by Mr. G. A. Hulett, of Princeton, in the July number of the *Physical Review*. A wide-necked bottle of about 8 cm. diameter contains a layer of mercury half a centimetre thick covered to a depth of 4 cm. or 5 cm. by a solution of 10 c.c. of strong sulphuric acid and 800 grams of cadmium sulphate crystals per litre of water. A glass tray about 4 cm. diameter and 4 mm. deep is supported in the solution a little above the surface of the mercury, and contains the 12½ per cent. cadmium amalgam. Contact is made with the mercury and the amalgam by means of wires enclosed in tubes. The mercurous sulphate is prepared in the cell by sending a current through the cell from the mercury to the amalgam, the solution being kept well stirred during the process. The internal resistance of such a cell is about 6 ohms, and it is capable of giving a current of 0·00001 ampere for many days without its electromotive force varying appreciably. A larger cell has been used to give a constant current of 0·04 ampere for a long period for bolometrical work.

IN the case of the majority of the ions Prof. Arrhenius's assumption that the mobility is independent of the concentration holds good through a considerable range of dilute solutions, though variations occurring in stronger solutions are well known, and have been investigated by Jahn, by Bousfield, and by others. The hydrogen ion appears, however, to be an exception. For some years doubt has existed as to the correct value for its mobility, transference experiments at moderate dilutions having given a value 330, considerably higher than the value 315 deduced from conductivity measurements at extreme dilutions. This discrepancy has been traced by Noyes and Kato, who describe their observations in a recent number of the Journal of the American Chemical Society, to variations in the mobility of the hydrogen ion occurring at dilutions much greater than those at which the mobilities of the other ions become constant. Concordant values were obtained from independent observations with hydrochloric and nitric acids, and the evidence for the reality of the variations of mobility appears to be complete. The numbers given in the following table show the magnitude of the changes involved:—

Concentration	HNO_3	0·058	0·0184	0·0067	0·0022	0
	HCl	0·051	0·0170	0·0056	0·0021	0
Mobility ...	HNO_3	350·3	340·2	339·1	332·2	324·6
	HCl	344·2	340·5	341·4	331·8	324·0

THE Harben lectures of the Royal Institute of Public Health, delivered by Prof. Paul Ehrlich last year upon the subject of "Experimental Researches on Specific Therapeutics," have been published by Mr. H. K. Lewis, Gower Street, in the form of a small volume, having a portrait of the lecturer as a frontispiece. The price of the volume is 2*s*. 6*d*. net.

FOR the third year in succession the Library Association has published its "Class List of Best Books and Annual of Bibliography." The work is a classified and annotated catalogue of important works which appeared in the year ended on June 30. The previous year's issue comprised 1800 titles; this year the number has risen to more than 2500. The publication should be useful both to the general reader and the student as a guide to recent literature of noteworthy value.

THE third edition of Prof. H. Snyder's "Soils and Fertilisers" has just been published by the Macmillan Co., New York. The second edition was reviewed in NATURE of January 18, 1906 (vol. lxxiii., p. 266); and though the work has been enlarged and revised, no further description of its contents is necessary. It is sufficient here to say that the book presents in a concise form the scientific principles involved in the successful treatment of the soil and the production of crops.

OUR ASTRONOMICAL COLUMN.

THE ORIGIN OF THE RECENTLY DISCOVERED JOVIAN SATELLITES.—Criticising Prof. Forbes's recent suggestion (NATURE, p. 30, No. 2011, May 14) that the newly discovered eighth satellite of Jupiter may in reality be the long-lost Lexell's comet of 1770, captured by the giant planet in 1779, Prof. Tarrida del Marmol conjectures that a more likely explanation of the origin of the sixth, seventh, and eighth satellites is to be found in the suggestion that they are asteroids which revolved at the same distance from the sun as Jupiter, and were captured by the latter. He shows that if the asteroid be either further away from, or nearer to, the sun, the annexation cannot take place, but when the distances are equal the asteroid will, with its relatively negligible mass, be effectively the inferior planet, and will suffer capture. The recent discovery of the four Jovian asteroids Achilles, Patroclus, Hector, and 1908 C.S., strengthens the possibility of this conjecture. Prof. del Marmol concludes his note, which appears in the August number of *Knowledge and Illustrated Scientific News* (vol. v., No. 8, p. 185), with the tentative suggestion that the Saturnian satellites Hyperion, Themis, and Phœbe may have been captured by Saturn in the same manner.

In answer to our inquiries concerning the above suggestions, Mr. Melotte, the discoverer of Jupiter's eighth satellite, points out that the images found on the plates give no indication whatever of diffuseness, such as might be expected from a cometary body, but are in every respect similar to the photographed images of the other faint satellites. According to Hind, Lexell's comet, when nearest the earth, exhibited a white nebulosity surrounding the nucleus and subtending an angle of 2° 23′, although no tail was visible. Mr. Melotte also suggests that others of the major planets may be attended by satellites hitherto undiscovered by reason of their faintness, and that the motions of these may subsequently be found to be retrograde, thus reducing the importance of the anomalies which have hitherto puzzled astronomers in considering the origin of the satellites under discussion. In conclusion, he adds that possibly Prof. del Marmol intended to write Japetus in place of Themis, as, so far as is known, the latter rarely reaches a distance of 220″ from Saturn.

ELEMENTS OF THE ORBIT OF JUPITER'S EIGHTH SATELLITE.—Circular No. 102 from the Kiel Centralstelle contains the following equatorial elements for the orbit of Jupiter's eighth satellite, computed by Messrs. Crawford and Meyer and communicated telegraphically by Prof. E. C. Pickering:—

$$T = 1908 \text{ August } 25{\cdot}72$$
$$\left.\begin{array}{l}\omega = 51^\circ\ 9' \\ \Omega = 236^\circ\ 12' \\ i = 145^\circ\ 48'\end{array}\right\} 1908{\cdot}0$$
$$q = 0{\cdot}103$$
$$e = 0{\cdot}4395$$
$$\text{Period} = 2^{y}{\cdot}55.$$

Osculation, 1908 March 8, 19h. 45·5m. G.M.T.

SEARCH-EPHEMERIDES FOR COMET TEMPEL$_2$-SWIFT.—Three ephemerides for the comet discovered by Tempel in 1869, and recognised as periodical by Swift in 1880, are published by M. E. Maubant in No. 4269 of the *Astronomische Nachrichten* (p. 349, August 14). These ephemerides give the positions of the comet from August 29 to November 1, the times of perihelion being taken as September 22·88, September 30·88, and October 8·88 respectively. The following is an extract from the ephemeris for the mean date:—

Ephemeris (12h. M.T. Paris).

1908	α (h. m.)	δ (° ′)	log r	log Δ
Aug. 29	4 18·8	+30 39·0	0·0879	9·8615
Sept. 2	4 40·0	+31 27·9	0·0822	9·8542
„ 6	5 1·5	+32 3·5	0·0771	9·8484
„ 10	5 23·0	+32 25·4	0·0727	9·8440
„ 14	5 44·3	+32 33·5	0·0689	9·8409

From this ephemeris it is seen that the comet is travelling eastwards through Taurus to Auriga, and may be discovered during the early morning before dawn. Its period is about 5½ years, and it was well observed in 1891, although at its more recent returns in 1897 and 1903 it was not seen. On September 9 the comet should be about 4° N. of β Tauri, which rises about 10 p.m.

DEFINITIVE ORBIT OF COMET 1826 V.—No. 4269 of the *Astronomische Nachrichten* (p. 341, August 14) contains a discussion, by Herr A. Hnatek, of Vienna, of the orbit of comet 1826 V, from which the author deduces that the orbit was parabolic, the most probable ellipse giving a period of nearly 28,000 years. Herr Hnatek directs attention to the fact that in the early hours of November 18, 1826, the comet grazed the sun.

RELATIVE DEPTHS OF THE SUN-SPOTS OF A GROUP.—Discussing stereocomparator measures which he has made on photographs taken at Greenwich on July 4, 5, and 6, Prof. Wilhelm Krebs, in No. 4267 of the *Astronomische Nachrichten* (p. 315, August 7), shows that the different spots of the group which was then near the central meridian were at different levels, and also that the changes of level varied from spot to spot during the intervals between the taking of the photographs. Whilst the most easterly spot showed a sharp increase of height above the datum line, the most westerly exhibited a sharp fall. The different heights, measured in 1000 km., varied from 137 to −3, whilst the general increase in height during the two intervals amounted to 17,000 km., or 27 per cent.

AN ALLEGED EXCRETION OF TOXIC SUBSTANCES BY PLANT ROOTS.[1]

THE idea formulated a century ago by de Candolle that plant roots excrete toxic substances has recently been very much pushed forward by the American Bureau of Soils to explain the effects of fertilisers and the advantage of a rotation of crops. The American method of experiment is to grow seedlings in water culture for a few days and measure the amount of transpiration, which is considered to be an index of the amount of growth. The seedlings are then removed and replaced by a second batch, without changing the water; the rate of transpiration is found to be diminished, showing (it is stated) that a toxic body excreted by the roots of the first batch is adversely affecting the second. Further, seedlings grown in an aqueous extract of certain poor soils are found to transpire less water than others grown in distilled water, and it is concluded that these soils contain some toxic material, presumably excreted by plants. The toxic body is, however, precipitated on addition of charcoal, ferric hydrate, and solutions of various manures; and the Bureau of Soils argues that the function of fertilisers, in some cases at any rate, is not to feed the plant, but to precipitate the toxin excreted by previous plants. Rotations of crops are of advantage, because the toxin excreted by one plant is not necessarily harmful to plants of a different order.

It cannot be said that any very convincing evidence is offered in support of this view. The assumption that transpiration is a measure of plant growth is not borne out by any of the figures quoted; thus in a series of experiments given in Bulletin No. 36 the crop weights and transpiration results are:—

Experiment	1	2	3	4	5	6	7	8	9
Transpiration	100	126	116	107	116	133	119	147	111
Crop weight	100	108	95	100	103	112	107	129	108

Another weak point is that the experiments are made with seedlings, and last only a few days, instead of being carried on to the end of the plant's life. The nutrition of the seedling is not the same as that of the plant, and even if it were demonstrated that secretion from seedling roots took place, it would not follow that there was a similar secretion from the roots of fully grown plants.

In the last Bulletin from the Soil Bureau (No. 48) an account is given of more than 13,000 pot trials with soils from different parts of the United States. The results show, as might be expected, that addition of manures increases the crop, and that each manurial substance exerts a specific effect which is not shown by any other; with this statement everyone would agree. The further conclusion is drawn that the character of fertiliser required depends more upon local conditions and practices than on the type of soil or the geological formation to which it belongs, so that the fertilisers required for the same type of soil as it occurs in different localities usually vary more than those required for very different types when in the same locality and subjected to similar environment. If this generalisation turned out to be true, it would be more easy to reconcile with the plant excretion view than with the nutrition view of the function of fertilisers, but an examination of the tables does not show that there is any proof. Averages are taken without any regard to their probable value. Thus in one section of the table we find three soils only, and they give the following percentage increases when treated with various manures, yet the author finds no difficulty in taking an average:—

Soil	Percentage increase given by manures supplying		
	Potash	Phosphoric acid	Lime
Cecil sand	−8	−15	8
Cecil sandy loam	3	40	33
Iredell clay loam	6	0	3
Average	0	8	15

The magnitude of the experimental error can only be inferred from one table, where the separate crop weights for twenty pots are given; it would appear to be considerable, since the weights vary from 58·7 grams to 89·9 grams; but the author groups the pots in sets of five, and in this way reduces the error to 5 per cent., which is given as the probable error for all the experiments! There

[1] (*a*) "Fertility of Soils as affected by Manures." By Frank D. Gardner. (U.S. Department of Agriculture, Bulletin No. 48.)
(*b*) "Note on a Toxic Substance Excreted by the Roots of Plants." By F. Fletcher. (Memoirs of the Department of Agriculture in India, vol. ii., No. 3.)
(*c*) "Crop Rotation and Soil Exhaustion." By F. Fletcher. (Cairo Scientific Journal, vol. ii., No. 19.)

would be no particular difficulty in maintaining any thesis if results could be treated in this way.

Mr. Fletcher's work has been partly on the above lines. He obtained a "solution of excreta" by growing plants in water culture, and then used this solution as a medium for plant growth. It proved to be toxic, and the conclusion is drawn that the plant first used excreted some poisonous body. The experiment, however, is not a very good one. It is well known by those who have worked with water cultures that bacterial decompositions are liable to take place in the solution, producing substances injurious to plants; precautions always have to be taken to prevent development of bacteria. It does not appear that any such precautions were taken by Mr. Fletcher, indeed, the conditions under which he worked seem to have been favourable to bacterial development; well water was used, and the "solution of excreta" was allowed to evaporate at ordinary temperature until sufficiently concentrated for the second part of the experiment. There is no evidence that the toxic substance was excreted by the plant; it might equally well have been a bacterial product.

In another set of experiments crops were grown in rows side by side, and three lots of measurements were taken:—(1) the yield in the outside row, bordering on the bare ground; (2) the yield in the middle row; (3) the yield in a row bordering on another crop. The first is the highest, the second shows the effect of the plant on others of the same kind, and the third shows the effect on others of a different kind. The falling off in yield in the second and third cases is regarded by Mr. Fletcher as proof of a toxic excretion; it is generally explained as due to lack of water or food, and no satisfactory evidence is adduced against this view; indeed, Mr. Fletcher states that the reductions in crop are less marked under a more evenly distributed rainfall. We cannot consider that the question of root excretion has been materially advanced in any of these publications.

E. J. R.

ACID-RESISTING ALLOYS.

A PAPER was read at a recent meeting of the Faraday Society by Mr. Ad. Jouve describing the remarkable resistive character of ferro-silicon and other silicon alloys. Attention was directed to the fact well known to analysts that no methods of analysis for this substance, based upon the use of acids, with the exception of hydrofluoric acid, are employed for ferro-silicons, because ferro-silicon containing more than 20 per cent. of silicon is insoluble in acids. This protective property of metalloid is being made use of in producing acid-resisting vessels. Ferro-silicons, however, are not the only substances which possess this property; almost any alloy of a metal with this metalloid will behave in the same way to a greater or lesser degree, according to the nature of the metal. Calcium-silicide is, for example, unaffected by acid, whereas calcium itself acts vigorously upon water.

As showing the resistance of these alloys, which are called "Métillures," to acids, the following example is interesting:—Nitric acid, even as a vapour such as is obtained at the exit of a bisulphate retort or when mixed with nitrous acid, does not affect them at all. A striking example of this is given by a pipe which has been submitted for nearly five years to the daily passage of 660 lb. of nitric acid vapour at temperatures varying from 150° to 200° C. without its loss in weight exceeding a few decigrams in a total weight of a score of kilograms. This loss occurred quite at the beginning of the period, and was probably due to a few impurities remaining on the inner surface of the pipe after fusion.

Sulphuric and hydrochloric acid appear to have still less effect, and pipes of ferro-silicon have been used for carrying and condensing gaseous hydrochloric acid. Acetic acid and the mixture produced by treating calcium acetate are also without action. Seeing the extremely high price of platinum, which is the most stable of all industrial metals, it would appear probable that the advent of these new resisting alloys will become of very considerable importance. The chief drawback to their use is in the brittleness and weight of the alloy, the vessels made of it being generally rather thick.

CERTAIN ASPECTS OF THE WORK OF LORD KELVIN.[1]

WHEN a man of the first magnitude works continually at a single group of subjects from an age preceding twenty to an age exceeding eighty, the circumstance is so exceptional and the output so enormous that no ordinary summary or criticism can do it justice.

I shall not aim at any chronological sequence, and, in fact, propose to begin with those later physico-philosophic views which seemed to determine the direction of his thoughts and the attitude of his mind to nascent and contemporary discoveries in recent years.

For this aspect, even if difficult to treat of, is one which a biographer is bound in some fashion or another not to shirk; and, although myself unable to regard it with full sympathy, I am confident that my point of view is neither presumptuous nor disrespectful.

KINETIC THEORY OF SOLIDITY.

Now, I confess that for some years before his death Lord Kelvin's attitude to fundamental physical or philosophical questions was somewhat of a puzzle to me. He seemed to be abandoning ground which he himself had opened up to explorers, and discouraging others from advancing in directions where he himself had pioneered. As a matter of fact, I was uncertain whether his position was even consistent and logically tenable or not; and at the British Association meeting at Leicester, during a discussion on the constitution of the atom in Section A, I had an opportunity of respectfully and deferentially challenging him on this subject. He responded, as always, in the kindest manner, and with great and almost exceptional lucidity indicated what had now become his position. I would not be understood as implying that he carried conviction, or led me to regard that position as a desirable one to occupy; but he showed it to be a consistent and logical one, which he had every right to occupy if he chose, and on which, therefore, it must be left for posterity, or at least for effluxion of time and progress of discovery, to pass anything in the nature of ultimate judgment.

I was much interested in this pronouncement, and before leaving Leicester jotted down a few notes concerning it, with the view of publishing them in his lifetime, in order that he might, if he chose, add to, or subtract from, or modify the statement. Other things prevented rapid publication, however, and accordingly it is too late for one of the objects in view, but still the notes are worth publication as suggesting genuine antithetical or alternative views of the universe. (They have now appeared in NATURE for July 2, 1908.)

It may seem as if the real antithesis was between the postulates of a connecting medium, on the one hand, and of action at a distance across empty space, on the other, and as if Lord Kelvin were in favour of the latter view. I do not, however, think it would be fair to attach to him that responsibility. I think it was more a matter of practical politics, with him, than a philosophical conception. I think he would have liked to see an explanation in terms of a connecting medium, if it could have been managed; but, after spending some years in the attempt, he abandoned it either as too difficult or as hopeless, and constrained himself to be satisfied with unexplained forces between masses of matter acting according to specified laws; the question of the medium or mechanism through which they acted being left out of account as unnecessary from the point of view of practical dynamical calculation and consistent reasoning.

He did speak at times, however, as if immediate action across empty space would be logically satisfactory to him, and quite good enough as an explanation; the only question being, was it the true one? To me I confess that any such philosophic scheme must necessarily be a cold and merely descriptive account of material activity—that it must necessarily fail to go to the heart of the matter or to constitute what may more reasonably be called "explanation." The conception of forces acting according to a specified law of distance is capable of yielding dynamical results truly, but not of explaining them. Ex-

[1] Abridged from the presidential address to the Faraday Society, delivered by Sir Oliver Lodge, F.R.S., on May 26.

planation, however, is never ultimate; so it may be that the process contemplated, and in his last years energetically worked at, by Lord Kelvin is an intermediate stepping-stone, which must be taken in order to cross to some more stable resting-place beyond; just as has happened in the case of gravitation.

The above is an attempt fairly to represent what I conceive must have been in the mind of our great leader, and it was a kind of pronouncement which I hoped to draw from him by the publication above mentioned. If he had been living it would have been presumptuous to try and state more concerning his views than he himself had indicated; and still it is to be hoped that anyone acquainted with his mind on this matter will make the necessary corrections.

ENERGY.

If we now proceed to ask what great generalisation will for ever be associated with Lord Kelvin's name, and in future ages stand out as his greatest achievement, it is not easy amid the wealth of material to focus it clearly. A few days ago I myself should not have been certain, if suddenly catechised, what my answer would be to such a question. But in preparing this address, and reading once more some of his early papers, I find nothing greater than what emanated from him in and about the year 1851, when he was immersed in the doctrine of energy. I do not mean, of course, any single year exactly, but about that period of his life; for in the records of that time are to be found, I think, his greatest and strongest memoirs.

The keenness and penetration of his mind at that epoch must have been something astounding. With all his mathematical powers alert, with tremendous natural genius, and extraordinarily vivid interest in phenomena of all kinds, he seized the facts concerning energy as they emanated from Carnot and from Joule, and with them in his mind, more powerfully and persistently than even Helmholtz, he brooded over the whole domain of physics until he elicited therefrom a series of the most beautiful and striking discoveries—discoveries which, as they have gained in familiarity, have perhaps lost something in charm, by constant iteration in text-books and college lectures, but which, in their freshness, well repay an attentive perusal; though their form is far inferior to their substance.

So I expect that the answer of posterity, to the question above mooted, will be that his most immortal work is the development and application of the doctrine of the conservation of energy, together with the comprehension and elaboration of the laws of thermodynamics.

Later he became more immersed in the work of the world, managed a great deal of practical business, and made many inventions of surpassing ingenuity; but although all this later work is the best known to the general public—if, indeed, any scientific work can be said to be really known to that body—yet for pure genius, to my mind, nothing since Newton comes up to his achievement in the fifth and sixth decades of the last century, especially from 1848 to 1856.

The comprehensive recognition, and extraordinary application to physics, of Carnot's brilliant "Reflections on the Motive Power of Fire," or, as we should now say, *On the efficiency of heat engines*, must have been largely due to Lord Kelvin's influence, and to the clear and enthusiastic way in which he took up and developed the subject. It is singular that this discovery of the second law of thermodynamics, which came historically first, created a real difficulty and obstruction in the recognition of the truth of what is now called the first law; and Joule's work would not only have been rejected by the Royal Society, as it was, but would have met with a total lack of recognition, or even disdain, had it not been for Lord Kelvin's perception of its value at a meeting of Section A of the British Association in 1847. In fact, the development of the whole subject of thermodynamics, though extensively carried out by Clausius and others, must have received strong initiative from him.

But it was not the mere recognition of the true nature of heat as a form of energy—so that when work was done by a fall of temperature the heat removed was less than the heat supplied, thereby breaking down the hydraulic analogy—but it was the way in which, both by Lord Kelvin and Helmholtz, the conservation of energy was applied all over the ground of physics, and especially so as to incorporate electrical phenomena with the rest, in one scheme, that was most remarkable.

Of all the memoirs dealing with the conservation of energy as applied to electricity, perhaps the most striking, though one of the simplest, is Lord Kelvin's early paper on transient currents, or the discharge of an electric capacity; wherein he gives the whole theory of electric oscillations, in so far as they can be treated without recognising the radiation which accompanies them—a discovery reserved for Maxwell. . . .

The extraordinary magnitude of the giants in physical science, especially in mathematical physics, during the Victorian era, and, indeed, throughout the nineteenth century, will probably be recognised more fully by posterity than by us. It will be many generations, probably many centuries, before the general and literary world can receive any adequate impression on the subject, or begin to understand their methods and their more recondite results.

SPECIFIC HEAT OF ELECTRICITY AND VOLTA FORCE.

It seems to me an amazing piece of insight which led Lord Kelvin at that date, 1851, to attribute to electricity, even hypothetically and only for convenience, something akin to real specific heat. The fact was really discovered in 1851, though he did not verify it experimentally until 1856 (see pp. 246 and 319, &c., of that monument of human power, vol. i. of "Math. and Phys. Papers"). The modern theory of electrons—which are now supposed to be flowing in great crowds through a conducting metal, and which, by their irregular motions, must account for some of the heat energy of a substance, in addition to the much larger portion corresponding to the motion of the atoms—seems to justify this curious expression, "specific heat of electricity," to an unexpected degree; and thermoelectric phenomena may be stated in terms of a definite pressure of these mobile and detached electrons in any given substance, after the fashion of the pressure of a gas or the osmotic pressure of a salt dissolved in a liquid.

There is, indeed, no obvious reason for denying that the Volta force might be expressed in this way too, were it not that a perfectly valid *vera causa* for this effect is to be found at the surface of the metals, where they are in contact with air or other chemically potential material; and that the magnitude of the effect, so calculated, from electrochemical and thermal data, agrees with observation in absolute as well as in relative value. These and other facts lead me to maintain that Volta force is an incipient display of potential but not actual chemical activity, at the bounding surface of a metal and a dielectric. But I ought to say that Lord Kelvin differed from this view in 1884, and that he still might not agree with all that is implied in this summary statement.

THERMOELECTRICITY AND GAS THEORY.

The splendid way in which the second law of thermodynamics was applied to the phenomena of thermoelectricity, so as to establish the laws of a thermoelectric circuit, is too well known to demand notice here. The chief features of it are to be found on p. 249 of Lord Kelvin's "Math. and Phys. Papers," vol. i.; but the enterprise was, I think, to some extent attended by good fortune, such as often rewards those who do not hesitate to risk something in the development of a theory, leaving it to be corrected, if necessary, by the future. (J. R. Mayer's theoretical estimate of J is another illustration.) It so happens that the thermoelectric theory has demanded very little correction, in spite of the intrinsic uncertainty attending application of the second law to an operation which had one irreversible feature about it—which might have been more relevant than it turns out to be—viz., heat conduction.

As an example of the opposite tendency, however, in Lord Kelvin's mind—for it was a mind which at times was extremely cautious—I think I may instance the difficulty he felt about the Boltzmann-Maxwell theory of the distribution of molecular energy. He always seemed to be troubled with a persistent difficulty about the innumerable degrees of freedom possessed by a molecule, and was unwilling to accept the position that many of these degrees of freedom were out of the running, so to speak—were beside the mark, for the purposes of gaseous theory, inasmuch as it was only those which affected, and were affected by, *collisions* that really mattered. Anything like organised motion, such as that of the planets, is out of the running, of course, and so is any internal motion of the parts of an atom which collisions do not produce or lessen or in any way affect.

It may be said that some collisions, like those which result in chemical combinations, do shake the parts of an atom—as is known by the emission of light. That is quite true, but then these collisions are exceptional, and, moreover, energy so transferred is speedily radiated away. The Boltzmann-Maxwell theory only applies to that which remains a permanently constituent portion of the heat energy of the substance—that is to say, the energy effective in producing pressure and the other manifestations of temperature—the unorganised random collision energy; it is this alone which need ultimately distribute itself equally among the parameters, through the agency of innumerable encounters. It is probable, however, that Lord Kelvin would not concur in the simplicity of this statement; he continued to be impressed by outstanding difficulties.

DISSIPATION OF ENERGY.

Of Lord Kelvin's work in connection with the dissipation of energy I shall not say much. I fancy that he himself, and certainly some of his disciples, have been at times inclined to attribute to the law of degradation more ultimate and cosmic importance than properly belongs to it. Its significance is limited to the validity of the terms "heat" and "temperature"; and if for any reason those terms cease to have a practical meaning, then the dissipation of energy also ceases to be inevitable. The theory, as originally stated by its author, was formulated as an axiom beginning, "It is impossible by means of inanimate material agency," &c., which at once conveys a suggestion that by some other means it may be possible. The different availabilities of energy of various kinds must be essentially a human and temporary conception, useful and convenient for practical purposes, but not ultimate or cosmic. What devices there are for thrusting aside the inevitableness of dissipation, and so evading the goal of ultimate stagnation, I do not know; they have not yet been discovered by us; but there is nothing inconceivable about them. Maxwell's "demons" is one attempt in that direction; nitrifying bacteria have been suggested as another. It is not at all certain what the influence of "life" may be; and all these agencies have to be eliminated if the uncompromising dissipation of energy doctrine is to be accepted. It was not originally stated in quite uncompromising form (see p. 514 of vol. i.).

The *conservation* of energy is a very different thing; that applies to every form, and is a comprehensive law; but the dissipation of energy has no meaning in circumstances when "heat" and "temperature" are obsolete terms,—that is to say, when what we now consider to be unorganised and intractable molecular motions can be dealt with in an individual and organised way. Ultimately and absolutely no operation need be irreversible. Irreversibility means only that things have got temporarily beyond our control, as a fire does sometimes.

ABSOLUTE MEASUREMENT.

To Lord Kelvin, more than to anyone else, we owe the realisation of the system of absolute measurement applied to such intractable quantities as are found in electricity and magnetism; and if the world decides to call its commercial electrical energy unit—now commonly spoken of, in insular fashion, as a Board of Trade unit, or B.T.U.—by the universally known and appreciated name of "a Kelvin," such a procedure will be entirely appropriate.

Counting, or the enumeration of discrete quantities, is a very easy and natural operation; but measurement, in the sense of expressing the warmth of a day, or the brightness of a light, or the strength of a current, or the field of a magnet, or the resistance of a wire, or the transparency of a window, or the elasticity of a metal, or the conducting power of a gas, in numerical fashion, is not by any means a simple thing; it usually needs great ingenuity, and sometimes can hardly be done.

The invention of suitable units, and the mode of expressing currents and electromotive forces and resistances in such units, is very far from being an obvious notion; and even now the full meaning of the idea of absolute measurement is not in all quarters quite clear. In the first instance it was not always quite clear, I venture to say, even in the mind of Lord Kelvin himself; and a certain partial incompleteness was almost necessary in order to reduce electric and magnetic quantities to simple mechanics. For, as a matter of fact, they cannot be reduced to simple mechanics, or, at least, have not yet been so reduced; and it was by partially blinding ourselves to that fact that the ideas of the ohm, the ampere, and the volt were attained. We used to be told that resistance was a velocity, and that electrostatic capacity was a length, also that self-induction was a length, and so on. But, of course, resistance is not a velocity, nor is self-induction or capacity a length. Nevertheless, had it not been for this partially erroneous simplification, the introduction of any system of electric measurement would probably have been seriously delayed. Incidentally, it may be noted that the magnetic method of measuring resistance, or "determining the ohm," was devised by Weber. Kelvin's first method was based upon Joule's law (see p. 502, vol. i.).

ABSOLUTE TEMPERATURE.

One of the remarkable achievements of Lord Kelvin has been the conception and determination of absolute temperature. The idea of an absolute temperature—that is to say, of a temperature reckoned from a real and actual zero, not a conventional one, and specified so as to be independent of the properties of any particular substance—follows rather naturally from the second law of thermodynamics, and from the fact that the efficiency of a perfect or reversible heat engine is independent of the properties of the working substance—being dependent only on the temperatures at which heat is supplied and withdrawn. Absolute temperature is, in fact, the reciprocal of Carnot's function, as Kelvin showed in 1848 (p. 100, vol. i., "Math. and Phys. Papers"). And the absolute zero is the temperature at which the working substance has exhausted all its heat in doing work, so that there is none to yield up as waste—the temperature, in fact, at which a condenser or "cold body" becomes unnecessary.

On a thermal diagram a *scale* of temperature can easily be drawn, as the rungs of a ladder between two adiabatic lines, such that the area of each space is the same; and in order to find the number of rungs, with a given-sized degree, it becomes a matter of experiment to determine the total heat obtainable from an isothermal operation performed on the substance to which the adiabatic lines belong. The measurement necessary can be made upon any substance—steam or anything else—but it must be dependent on an actual operation (say an expansion)—not a closed cycle of operations—and on a measurement of the change of energy therefrom resulting.

Lord Kelvin gives as the general expression for the absolute temperature of any substance whatever, the internal energy of which is E,

$$T=\left(p+\frac{dE}{dv}\right)\frac{dT}{dp}-\frac{dE}{dp}\cdot\frac{dT}{dv} \quad . \quad . \quad . \quad (A).^{1}$$

For an ordinary gas $\frac{dE}{dv}=K+c\frac{dT}{dv}$, where K is Laplace's cohesion constant; and $\frac{dE}{dp}=c\frac{dT}{dp}$; so this expression (A) agrees with what we obtain below as equation (5).

The actual determination, as hitherto experimentally made, of the zero of absolute temperature, below which it will be for ever impossible to cool bodies—since at that temperature they possess no heat, and, therefore, cannot have any more removed—may be said to depend (not necessarily or theoretically, but actually as the simplest method in practice) on the conception of a perfect gas in the first place;—that is, one of the molecules of which act upon each other and upon the surrounding walls solely by bombardment, there being no cohesion whatever between the molecules. The temperature at which the pressure of such a

[1] See "Encyclopædia Britannica," article "Heat."

gas becomes zero must be simply the temperature of absolute molecular rest, and, therefore, will be the absolute zero. From the properties of such a gas its absolute temperature could at once be experimentally determined, if only such a gas were available for experiment; for it would come out as the reciprocal of its coefficient of expansion. But as a perfect gas is not available, an imperfect gas has to be employed, and a correction made for the amount of its imperfection; the amount of this correction being deduced by reasoning based on its behaviour when subjected to an irreversible operation. For instance, it may be allowed suddenly to expand adiabatically in such a way as to do no external work, and, therefore, not to cool itself if it were perfect, provided time is allowed for all eddies and streaming motions to subside; and we may then observe the actual consumption of heat or fall of temperature really produced—which would be proportional to the cohesion multiplied by the change of volume. The change of temperature so observed is the chief term in a correction to be applied to the reciprocal of the observed coefficient-of-expansion-under-constant-volume of the imperfect gas.

The experiment as first made by Gay-Lussac, September, 1806, and later independently and more exactly by Joule, of allowing a gas to double its volume inside a closed vessel, by opening a connection between a full and an empty portion of a vessel, was manifestly an interesting and suggestive experiment, and a check or verification of Mayer's hypothesis that the mechanical equivalent of heat could be obtained by equating the heat supplied and the work extracted from expanding air; but the full meaning and bearing of such an experiment is by no means obvious, and it is remarkable that it should lead to a determination of the zero of absolute temperature. For this purpose it has to be repeated in a more refined form—the oozing of gas as a steady stream from high pressure to low through a porous plug—and a determination made of the change of temperature resulting, when all eddies and organised kinds of motion have subsided, and when everything has become heat again, except what was lost in internal work.

It is well known now that the practical liquefaction of gases depends on this very effect; for, of course, without some cohesion between the molecules liquefaction would be quite impossible. The essence of liquefaction is the automatic subdivision of the contents of a vessel into two sharply bounded regions of different density, and the retaining of them in this condition for a time by internal molecular forces.

ABSOLUTE TEMPERATURE.

The elementary argument about the notion of absolute temperature in terms of a perfect gas can be put thus:—

A perfect gas is one the molecules of which act on each other, and on the walls of the containing vessel, solely by bombardment. Simple mechanics shows that such a substance exerts a pressure—

$$p=\frac{1}{3}\rho u^2; \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and whenever it expands all the work done is against external pressure.

The heat in such a body is solely the energy of its irregular or unorganised molecular motion—including rotation as well as translation; and the temperature of such a body can be defined as simply proportional to the heat, or equal to the heat divided by a capacity-constant mc.

If the gas has to expand against external pressure, more heat must be supplied to allow for the external work done, $\int pdv$; the capacity being now called mc' if the pressure is constant. Consequently, if the gas be heated at constant pressure, from absolute zero up to the temperature T, the heat required can be expressed as—

$$H=mcT+pv=mc'T;$$

wherefore—

$$p=\rho(c'-c)T \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which may be called the characteristic equation of the substance.

Comparing this with the first equation, we see that—

$$u^2=3(c'-c)T \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which constitutes a definition of absolute temperature in terms of the characteristic constant $c'-c$; the "3" having reference to the three dimensions of space.

Actually to determine T we can employ equation (2), and can get rid of the constant, say, by measuring the increase of pressure when the gas is heated at constant volume. This gives—

$$\frac{dp}{p}=\frac{dT}{T};$$

or—

$$T=p\frac{dT}{dp}=\frac{1}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

the reciprocal of the coefficient of expansion.

In other words, the expansibility of a perfect gas is simply the reciprocal of its absolute temperature.

This is consistent with the form of characteristic equation which allows for molecular bulk, though not for molecular forces—namely, $p(v-b)=RT$.

For a slightly imperfect gas there is the cohesion or molecular-attraction term to be attended to as well, and its characteristic equation is—

$$(p+K)(v-b)=RT,$$

K being a function of volume only. For constant-volume warming this gives—

$$\frac{dp}{p+K}=\frac{dT}{T},$$

or—

$$T=p\frac{dT}{dp}+K\frac{dT}{dp}$$

or—

$$T=\frac{1}{a}\left(1+\frac{K}{p}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where a is the coefficient of expansion as measured on a constant-volume thermometer; showing that a correction factor not far from unity must be applied, depending on the incipient cohesion or inter-molecular attraction, represented by Laplace's K or van der Waals's $A\rho^2$.

To get K we must perform a definite operation, say a sudden expansion δv, under adiabatic conditions, allowing no external work to be done; and we must observe the resulting absorption of heat, say by noticing the small change of temperature δT. It would be zero if the gas were perfect. If imperfect, the energy lost is $K\delta v$.

To ensure that no external work is done, the operation must be performed in a rigid vessel, and a steady stream of gas will carry off the defect of heat δH. The cooling will then be due only to internal work $K\delta v$; and the heat change can be expressed as $mc'\delta T$, when eddies have subsided.

Thus we get—

$$K\delta v=\delta H=mc'\delta T=v\rho c'\delta T;$$

but now instead of δv we may write $-\frac{v}{p}\delta p$, since the temperature is nearly constant, so that—

$$K=-\rho c'p\frac{\delta T}{\delta p} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Hence, denoting by θ the small observed change of temperature corresponding to the change of pressure Π, and substituting (6) in equation (5), we get finally as an expression for the absolute temperature of the gas experimented on—

$$T=\frac{1}{a}\left(1-c'\rho\frac{\theta}{\Pi}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Perhaps the equation looks still clearer if we write it in terms of the volume of air v streaming through the porous plug, down the difference of pressure δp, and carrying with it ultimately the defect of heat δH, measured anyhow; for then—

$$T=\frac{1}{a}\left(1+\frac{\delta H}{v\delta p}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7^1)$$

But the expression for the absolute expansion term—

$$aT=\frac{p+K}{p} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5^1)$$

is also a very simple one.

To interpret equation (7) numerically—

The quantity $c'\rho$ will be recognised as *the atomic heat*, which is nearly the same constant for all ordinary gases, and equal in c.g.s. energy units to—

$$0{\cdot}2375\times0{\cdot}001293\times(42\times10^6)=0{\cdot}001294\times10^6 \text{ ergs per c.c.}$$

for dry air.

The actual change of temperature per atmosphere, observed as the final result of the irreversible Joule and Thomson expansion, was, for air, a lowering of about a fifth of a degree, or more exactly $0^\circ{\cdot}208$; so that—

$$\frac{\theta}{\Pi}=\frac{0{\cdot}208}{10^6 \text{ dynes per sq. cm.}}$$

Hence, since *ergs per c.c.* are the same as *dynes per sq. cm.*, the value of what we have just reckoned as the dimensions of the whole term $c'\rho\theta/\Pi$ comes out right as a pure number (being plainly a ratio of two energies when ρ is written m/v); and the correction factor for air equals—

$$1+0{\cdot}001294\times0{\cdot}208=1{\cdot}00027.$$

At zero Centigrade the expansibility of air was measured by Regnault as 0·0036706. Wherefore the absolute temperature corresponding to zero Centigrade is, in accordance with equation (7)—

$$\frac{1{\cdot}00027}{0{\cdot}0036706}=273{\cdot}17.$$

Electrical Theory of Matter.

On the great modern region of physics centring round an electrical theory of matter, Lord Kelvin's mind was somewhat conservative; as perhaps it was in electricity generally, whenever results could not be obtained by straightforward dynamics or by energy calculations. In other directions he only advanced under protest, as it were, towards the goal at which others were enthusiastically working. Nevertheless, we owe to him some pioneering work even in this branch.

Comparatively modern speculation and calculation on the structure of an atom are contained in a remarkable paper by Lord Kelvin, published in the *Phil. Mag.* for 1901 under the curious title "Æpinus Atomised." It is reproduced in the volume of Baltimore lectures as Appendix E. It was probably the first attempt to work out the statics of an atom, according to a simple conception the major consequences of which can be traced with comparative ease, viz., that of a spherical portion of uniform positive electricity in which minute negative charges are sown like specks; being attracted towards the centre of the sphere according to the law of direct distance, and repelling each other according to the inverse square law.

Cosmic Calculations.

Of the work of Lord Kelvin in elasticity, I shall here say nothing beyond the remark that his kinetic view of elasticity often seems to me one of the most suggestive and ultimately pregnant of all his theories.

His papers on celestial dynamics are very remarkable and lucid, though we may not feel that they represent the last word on the question; any more than the last word has been said as to the age of the sun or of the earth. The fact that after a lifetime of immersion in all the intricacies of natural philosophy Lord Kelvin still postulated an origin or beginning for the material universe—a beginning when it was essentially different, not only locally but universally, from its present condition—and that he endeavoured to conceive what it might then have been like, in those early times—is a notable circumstance and one of general interest. To me there appears no reason for calling those times "early" rather than "late"; nor would I suppose a beginning or ending at all, either for space or for what is in space, other than such beginnings or endings as we might detect, or may hope to detect, somewhere, even now.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Prof. Wülfing has been appointed to the chair of mineralogy in the University of Heidelberg. We notice also that the same university has just celebrated the fiftieth anniversary of the doctorate of Prof. Georg Quincke, professor of physics in the University.

The correspondence between the Colonial Secretary (Mr. J. C. Smuts) and the council of the Transvaal University College relating to the organisation of higher education in the Transvaal has just been issued as a Blue-book (T.G.—24—1908). The question of a Transvaal university is not considered yet to be ripe, the proposals at present being for the establishment of a university college. If the recommendations of the committee appointed by the Colonial Secretary be carried out, the Transvaal University College will be a federation, under one council, of three institutes. The technical courses would be assigned to the Johannesburg branch, the literary and science courses to Pretoria, and the agricultural work would be centred at Frankenwald. It has been decided to proceed at once to carry out the scheme so far as it relates to the allocation of the various departments of work and study to the Pretoria and Johannesburg branches respectively. For the Frankenwald branch it is hoped that 200,000*l.* will be available from the Beit bequest, but this part of the scheme is deferred. Certain questions relating to the constitution of the reorganised college are also held in abeyance. It is obvious that the three branches will have but a slender bond of union; but after reading their report we are inclined to accept the view of the committee, that the difficulties in the way of finding any one place where the branches can be developed side by side are insurmountable.

The *British Medical Journal* for August 15 gives its readers a lengthy report of the discussion by the British Medical Association at Sheffield on the education of the medical student. The speakers included Profs. Starling, Armstrong, Sherrington, Sims Woodhead and Osler, Sir Felix Semon, Dr. Dawson Turner, Dr. Buist, and Dr. Russell Wells. The discussion formed part of the proceedings of the Section of Physiology, but the list of speakers guaranteed adequate handling of their theme in respect of scientific as well as clinical aim. It appeared to be widely held that (1) the period devoted to preliminary and intermediate study should be curtailed; (2) closer consideration should be paid during the intermediate course to the practical needs of the future medical man—*e.g.* biological studies should have a physiological rather than a morphological bias; (3) more clinical study is required in the later periods of the training, especially practice of diagnosis; (4) there should be fewer lectures and more demonstrations. The leading article in the same number of the journal is devoted to a consideration of this discussion jointly with the new regulations for the medical curriculum recently promulgated by the University of London. The journal approves the decision of the University to extend the final part of the curriculum to thirty-six months. We may point out that we are still behind the foremost Continental countries in our estimate of the time required to train a qualified medical practitioner.

A well printed and illustrated pamphlet has been issued by the British Education Section of the Franco-British Exhibition under the title "A Short History of National Education in Great Britain and Ireland." In the article which appeared in Nature for August 13 attention was given to the manner in which the exhibition, both as a whole and in detail, illustrates national progress, whether such progress be viewed from the pedagogic or from the administrative aspect. The booklet now before us deals with the latter aspect, and its author—Mr. T. L. Humberstone—gives a broad and clear outline of his subject. Too little is said of private schools, but the history of public provision for education during the last three centuries is made clear. The awakening of England and Wales during the last century to their responsibility for educating their citizens is traced with judgment, and mention is made of the latest development of this sense of responsibility shown by the medical inspection of school children. The value of this production is much in excess of its price—it is published by Messrs. King at 3*d*.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 17.—M. Bouquet de la Grye in the chair.—A problem relating to the theory of orthogonal systems and the method of the mobile trihedron: Gaston **Darboux.**—The detection of a particular class of rays which may be emitted by the sun: H. **Deslandres.** An attempt at an explanation of the phenomenon of the second twilight. M. Durand-Gréville has recently shown that this phenomenon is a general one, and is not confined to mountainous districts. If there are solar radiations of wave-length smaller than 0·1 μ, possessing an index of refraction greater than the known rays, and for which the ratio $n-1/d$ (n being the refractive index and d the density of the gas) is five or six times greater than with the luminous rays, the sunset for these rays would be about fifteen minutes after the sunset visible to the eye. It is further supposed that these ultra-violet rays excite phosphorescence in the atmospheric particles. These hypotheses would account for the second twilight, but further proof of the existence of such ultra-violet rays is necessary.—A hailstorm which followed the path of a high-tension circuit: J. **Violle.** This destructive hailstorm moved about 14 kilometres, and had a width of about 2 kilometres. It was remarked that its direction coincided very exactly with that of a high-tension line (45,000 volts). Owing to the fact that the permission of the owners had to be obtained in fixing this line, its course was sinuous. The most serious damage was done in the immediate neighbourhood of the wire, decreasing to the right and left, and ceasing altogether at about 800 metres to 1000 metres on each side. One of the owners of the district where the storm commenced was about 400 metres from the line, and observed three large spheres, twice as large as a man's head, which remained for a moment suspended, and the explosion of which was immediately followed by the fall of hail. These observations raise an interesting question as to the relation between these destructive hailstorms and lines transmitting electric energy under high voltage.—Periodic functions: P. **Cousin.**—The formation of fogs in presence of the radium emanation: Mme. **Curie.** The production of a mist in moist gases by the action of the radium emanation has been pointed out in an earlier communication. In the present paper an attempt is made to trace the cause of this phenomenon. It appears to be due to a chemical reaction under the influence of the emanation. In some cases the nature of the products has been determined with certainty; with carbon dioxide a little carbon monoxide is produced; air gives some oxides of nitrogen; sulphur and air produce traces of sulphurous and sulphuric acids. The mists produced are composed of very minute drops, not electrically charged.—Anatomical researches on the vegetative apparatus of the Geraniaceæ: Abel **Legault.**—The origin of the colour of black grapes: Philippe **Malvezin.** An account of the production of the red colour in grapes picked before the colour had developed. The results are in accord with the view of Duclaux, that there is only one chromogenic material in the grape, the transformation of which takes place under the simultaneous influence of air, heat, and possibly light.—The radio-activity of certain springs producing goitre: M. **Répin.** Various theories have been proposed to account for the production of goitre by certain waters. Two of these, the presence of a distinctive micro-organism or the presence of a rare mineral element, are regarded by the author as untenable from his researches. One singular property of such waters has been known for some time—the power of producing goitre disappears spontaneously after a certain lapse of time. This appeared to resemble the disappearance of radio-activity in certain mineral waters, and the author has examined several springs, well known to have the property of causing goitre, from this point of view. Three such springs were examined, and all were found to be radio-active, the one possessing the greatest radio-activity also being the one best known for its goitre-producing properties. There would thus appear to be a distinct parallelism between the two phenomena, and further work is being carried on from this point of view.—The optical properties of some contractile elements: Mlle. Doris L. **Mackinnon** and Fred. **Vles.** The contractile elements appear to form two groups from the point of view of their reaction between crossed Nicols; in the one the lighting is due to double refraction (muscular elements in general), in the other the lighting is due to depolarisation (cilia).—The changes in the nuclei of the lecithogenic cells of Rhabdocœles: Paul **Hallez.**—The persistence of the pronephros in Teleostea: Frédéric **Guitel.**—The fossil flora of Lugarde, Cantal: P. **Marty.**

CALCUTTA.

Asiatic Society of Bengal, August 5.—Major James Rennell's journals, 1764–7: T. H. D. **La Touche.** These are the original journals written by Major James Rennell, the first Surveyor-General of India, during his surveys of the rivers of Bengal, including an expedition up the Brahmaputra to the frontiers of Assam. They cover the period from 1764 to 1767, when Lord Clive was Governor of Bengal. Daily observations on the weather are given, and determinations of the variation of the magnetic needle at various places.—The Kosi River, and some lessons to be learnt from it: Captain F. C. **Hirst.** This paper gives an account of the past history of the Kosi River, its present condition, and of the considerations which, in the author's opinion, should govern any attempts made to control the river by embankments or otherwise.—A general theory of osculating conics (second paper): Prof. Syamadas **Mukhopadhyaya.**—Memoir on the surgical instruments of the Hindus, with a comparative study of the surgical instruments of the Greek, Roman, Arab, and modern European surgeons, part iii., the sharp instruments: Girindranath **Mukhopadhyaya.**

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