THURSDAY, FEBRUARY 2, 1899.

THE RECORDS OF THE ROCKS.

The Principles of Stratigraphical Geology. By J. E. Marr, M.A., F.R.S. Pp. 304. (Cambridge: University Press, 1898.)

GEOLOGY is admittedly a complex science, and Mr. Marr, no doubt rightly, speaks of it as one of the uncertain sciences. It is well for the student to be able clearly to discriminate between that which is ascertained and that which is inferred: and even individual knowledge may be dangerous when the limits of it are not clearly realised. The task of the stratigraphical geologist is, as the author points out, to establish the order of succession of the strata and to ascertain the conditions which existed during their deposition.

Possessed of a good general knowledge of the elements of geology and palæontology, the enthusiastic student will desire to engage in original observations in the field, and in the absence of the Cambridge University Lecturer in Geology, he will do well to carry this book with him. The chapter on the growth and progress of stratigraphical geology shows how much was accomplished in early days by traverses and sketch-maps, how the broad outlines were to some extent filled in on one-inch maps by subsequent observers, and how necessary it is nowadays to labour in greater detail and express the results of field-work on maps on the scale of six inches or even twenty-five inches to a mile. Experience in geological surveying is the best basis for further work—the student will then understand the structure of the ground, the local sequence of the strata and the nature of their organic remains. Even in geological mapping the uncertainties of the science, which Mr. Marr takes care to point out, are nowhere absent.

In considering the terms applied to sedimentary rocks, and the varying nature of the rocks themselves, we may feel that there is a want of precision in our language and in our geological boundary-lines; but the geologist soon learns that harmony and order are everywhere apparent amid the gradual changes of scene and life and climate which the strata reveal, and that their continuity is only locally interrupted. With regard to uniformitarianism the author rightly maintains that it is unphilosophical to hold that the agents which are in operation to-day are similar both in kind and intensity to those which were at work in past times. At the best our information is too incomplete to allow of dogmatism; and the student should be prepared "to consider that the more active operation of agents, even in times of which he has definite knowledge, may have produced effects which he should be prepared to discover."

Every year the labours of the student become more detailed. From the broad groupings of the old masters we have now to consider minute subdivisions in the strata, and the palæontological stages or zones which mark the succession of life. These detailed studies are all important when we seek to make out the chronology of the earth in general, but there is no doubt that much of the minute work in connection with the succession and evolution of species is more of a biological than a geological study. The geologist is mainly concerned with the natural history of successive periods, with the character of the formations, the conditions and climate which they indicate, and the movements to which they have been subjected.

In perusing this volume the student will find many a useful hint with regard to the superposition of strata, the effects of folds and faults, the included organisms whether original or derived, and the simulation of structures organic and inorganic. In considering the somewhat vexed subject of contemporaneity, the author is careful to point out that when we find the same fauna in different localities it is justifiably assumed that the species did not originate simultaneously in the two areas. Nevertheless, "everything depends on the time taken for migration as compared with the period of existence of the fauna." Thus we may "speak of the strata as contemporaneous, just as an historian would rightly speak of events in the same way which occurred upon the same afternoon, though one might have happened an hour before the other." The student will do well to bear in mind these remarks, for a few hours in our lives may be as a hundred, or even a thousand, years in the life-history of a zone.

Again, in reference to the recurrence of species, Mr. Marr observes that instances are by no means rare, but "that the whole fauna does not disappear for a time and then reappear, but only a few out of the many forms which compose it." Some remarks are naturally made on homotaxis, and to Huxley's assertion that a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America and with a Carboniferous fauna and flora in Africa. Subsequent researches have in no degree lent support to this notion, and we may be content to speak of practical contemporaneity without implying that absolute synchronism which it would be impossible to establish in comparing formations far apart. It is curious to note on p. 19, that Mr. Marr speaks of the Devonian system being finally placed "upon a secure basis," while on p. 184 he admits that the Devonian question is not settled. The fact is that the characteristic Middle Devonian fauna is distinct, but we do not yet know to what extent the Lower and Upper Devonian strata in this country include horizons elsewhere grouped as Silurian or Carboniferous.

After giving some account of the conditions under which strata are formed, the author reviews generally the successive stratified formations, both in this country and abroad, without entering into much detail. With regard to terms, we would not say that "Primary has been definitely abandoned." It is used by Sir A. Geikie in his "Text-book of Geology," by Prestwich in his "Geology," vol. ii., and by Lapworth in his "Intermediate Text-book of Geology" (1899). The term Permo-Carboniferous is useful as a temporary name for a group to which much attention is being given; but we would rather use Holocene than "The Forest Period" for the deposits often spoken of as Recent, and which succeed the Pleistocene. We have said enough, however, to indicate that the work will prove exceedingly useful to the

advanced student; it is full of hints and references, gathered during the author's long experience as a teacher and observer, and which will be valuable to all who seek to interpret the history of our stratified formations.

H. B. W.

THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM.

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S. In 2 Vols. Vol. I. Pp. xv + 479. (London: Macmillan and Co., Ltd., 1898.)

IN the preface to this book Prof. Gray defines his aim to be the presentation of the whole subject of electricity and magnetism from the point of view of action in a medium, and his method to be a preliminary consideration of the phenomena, followed by a development of the consequences of assuming that the medium is a receptacle of energy according to certain laws, and a proof that among these consequences the observed phenomena are included. At the same time, it is proposed that the work should not deal with theory alone, but should take account of its applications to questions of practical interest.

In following out the first part of this scheme the author commences with magnetism, reviewing the elementary facts, and showing how they are related to the condition of the media occupying the field. Then, as applications, come chapters on terrestrial magnetism and on the deviations of the compass in an iron ship. Next, the elementary facts of electrostatics and the theory of this part of the subjec are dealt with in a similar manner; they are followed by a treatment by the ordinary mathematical methods of a number of electrostatical problems and of the steady flow of electricity in systems of linear conductors.

At this point, in order to provide suitable mathematical equipment for the student of electromagnetism, two chapters are interpolated: one on general dynamical theory, in which Lagrange's and Hamilton's equations are explained; and one on hydrodynamics, which extends to the consideration of vortex motion.

The experimental results relating to mechanical actions between magnets and currents are next described, and their theory worked out; then, after a short account of the fundamental experiments on electromagnetic induction, the application of general dynamical principles to the treatment of a system of circuits is explained, and some problems on circuits with capacity and inductance are solved. A chapter on general electromagnetic theory follows, touching upon electromagnetic waves, the transference of energy in an electromagnetic field, and the behaviour of moving electric charges, with a short account of the Zeeman effect. Part of the subject of contact electricity next receives treatment, and the volume concludes with a short chapter on thermo-electricity.

It is the misfortune of an author with the reputation of Prof. Gray that general commendation must pass him by. To hint at his authority as a teacher, or to insist on the industry, learning and research displayed in his books, is wholly unnecessary; and, at the risk of appearing ungracious, it may be of more utility to bring forward objections, and to reveal blemishes for consideration and removal in a subsequent edition.

First of all, then, it is possible that after vol. ii. is written the author, having quarried the whole of his material, may find himself able to improve its general arrangement in some respects. In particular, we would plead for an early treatment of the phenomena of magnetisation in iron and steel, which surely is more germane to the plan of this treatise than the precedence given to terrestrial magnetism and ships' magnetism, for rearrangement and further elucidation in the domain of general electromagnetic theory, and for the postponement of contact electricity until it can receive fuller discussion in connection with electro-chemical phenomena and theories.

Secondly, as the book is clearly intended for the use of students, it may be urged in their interest that, whenever it is necessary to state a result which cannot be deduced from what precedes it, great assistance would be given by drawing attention to the fact. For example, the conscientious student will be discouraged by his failure to obtain the expression given at the end of § 498, and there is no hint that it must either be accepted as an article of faith, or traced to Prof. J. J. Thomson's "Recent Researches." Again, when he reaches the beginning of § 500, and reads concerning a perfectly conducting wire that "there would be no dissipation in it, but energy would enter it," he has not been supplied with the knowledge which would enable him to insert before "energy" the word "no," which has been omitted by the printer. Also, he may well be pardoned for complaining that the next sentence but one is a very hard saying indeed.

A few inaccuracies may also be pointed out. The numerical example on the torsion balance (§ 16) would present a difficulty to any one, if such a man there be, who is not familiar with problems on this instrument, and the difficulty would be intensified by the remark (§ 17) that "no account was taken of the earth's field in determining the forces acting on the magnet." In the description of Maxwell's dynamical model illustrating the induction of currents (§ 451), the long bar is wrongly stated to be rigidly attached to the axle of one of the wheels, when it is, in fact, free to rotate about this axis; but the analysis, which follows, exposes the oversight. A more serious error occurs in § 232, which states, and sets out to prove, that the actual distribution of currents in a net-work of conductors containing internal electromotive forces corresponds to a minimum rate of production of heat, *i.e.* that with the usual notation, $\Sigma(RC^2)$ is a minimum. The conclusion reached, however, is that $\Sigma(RC^2 - EC)$ has a minimum value which is zero, a plausible result, but due to an algebraical lapse, by which a term is omitted in the final equation. If this is corrected we obtain the true law, namely, that $\Sigma(RC^2 - 2EC)$ is a minimum, which is demonstrated in a foot-note to the third edition of Maxwell's "Electricity" (vol. i. p. 408).

These suggestions are put forward in no spirit of disrespect towards an author who has earned the gratitude of so many students of electrical science, but with the conviction that, in the case of a text-book, absence of errors is as great a recommendation as excellence of a less negative character.

L. R. W.

YOUNG'S GENERAL ASTRONOMY.

A Text-book of General Astronomy. By Charles A. Young. Revised edition. Pp. ix + 630. (London: Ginn and Co., 1898.)

EVERY student of astronomy is familiar with this well-known text-book, and it is not too much to say that it is as well used this side of the Atlantic as it is on the other. Written for a general course in colleges and schools, and meant to supply that amount of information upon the subject which may fairly be expected of "every liberally educated person," it is only natural that too great an attention to details must give way to more general statements. Since the first publication of this volume, now nearly ten years ago, astronomical science has made rapid changes and advances, and the time necessarily comes when minor alterations, notes, and addenda, &c., in subsequent editions of a text-book like this cannot be satisfactorily inserted without considerable difficulty, and probably detriment to the book itself. Prof. Young has therefore thoroughly revised his text-book, and it is this new edition that we have now before us. A glance through the pages of this book, with an occasional reference to the older volume, displays many differences and additions of new matter. In Chapter ix., for instance, we notice that the illustration of the tele-spectroscope has been replaced by a nearly full-page plate of the large grating spectroscope of the Halstead Observatory. In another paragraph, describing a sun-spot spectrum, an excellent reproduction of a photograph of the yellow-green portion of a spot spectrum is added, giving the reader a good idea of the meaning of widened lines in sun-spot spectra. Prof. Young refers in another paragraph to the so-called "reversing layer," describing the phenomenon as he saw it in the Spanish eclipse of 1870. The only additional matter here added is a brief note, in which it is stated that the photograph of the chromosphere taken in Novaya Zemlya in 1896 "fully confirms the author's visual observations, and appears to establish the reality of the 'reversing layer.'" We may mention that photographs taken at Viziadrug in 1898 were more numerous and on a far larger scale than any obtained previously, and have yielded very important results on this very question. Photographs of the so-called "reversing layer" were obtained on several plates successively exposed during twelve seconds, and a comparison of the chromosphere with the solar spectrum shows many important differences. In fact, to use Sir Norman Lockyer's own words (NATURE, No. 1515, vol. lix.)—

". . . practically the lower part of the sun's atmosphere, if present by itself, would give us the lines which specialise the spectra of γ Cygni or Procyon. I recognise in this result a veritable Rosetta stone which will enable us to read the celestial hieroglyphics presented to us in stellar spectra, and help us to study the spectra and to get at results much more distinctly and certainly than ever before."

In that part of the same chapter in which the photography of prominences and chromosphere is discussed, Prof. Young mentions that both Hale and Deslandres have devised ingenious arrangements (called *spectro-heliographs*) by which they are able "to obtain pictures of the chromosphere and prominences around the whole circumference of the sun at once." Although the text has been carefully perused, the author does not seem to have made it sufficiently clear that besides the phenomena *around* the circumference, those *on* the solar disc can be photographed by the same means.

In the chapter devoted to the planets and their motions we find that a thorough revision has taken place, and more especially in respect to the recent values of their elements. Prof. Keeler's beautiful confirmation of the meteoric theory of the satellites of Saturn by means of the spectroscope is clearly described and illustrated.

Lastly, it is interesting to note that in Prof. Young's opinion the meteoritic hypothesis is gaining ground, for to use his own words—

"While it would be premature to endorse this speculation of Mr. Lockyer's as an established discovery (since there remain in it many obscure and doubtful points), there can be little doubt that it marks an epoch in the history of opinion."

Before bringing this notice to a conclusion it may be stated that the present volume will continue to hold its high position among text-books on this side of the Atlantic. The same standard of clearness of exposition has been maintained throughout, and the illustrations are all to the point. Misprints are very few and far between, and only one has been discovered in our examination, namely, that on p. 536, line 11 from top, where "filled" is printed for "fitted."

W. J. S. L.

OUR BOOK SHELF.

The Campaign in the Tirah. By Colonel H. D. Hutchinson. Pp. xvi + 250. (London: Macmillan and Co., Ltd., 1898.)

THE "Campaign in the Tirah" is for the most part a reprint of the letters which appeared in the *Times* during the progress of that expedition, which were written by the author of the present book, and which must be fresh in the minds of the reading public. But Colonel Hutchinson has added to them an introduction in which he deals with the probable causes of the general outbreak on the north-west of India, and an appendix in which he sums up the lessons to be learnt from the campaign, and points the military moral of the whole story. Both these additions are valuable. From the point of vantage of his official position as Director General of military education in India, Colonel Hutchinson has been able to watch the development of those issues of our frontier policy which have been discussed so freely in England, with more discrimination, and with a more unbiassed mind, than falls to the lot of many public officials who are committed to the support of Government policy. And he is, at the same time, best qualified to gather instructive morals from the object-lessons of the campaign.

In the introduction we have a very clear expression of opinion as to the meaning of the outbreak, and the origin of it; and we shall probably not be far wrong if we assume that this opinion tallies closely with that of every frontier official who is in direct touch with Pathan communities, or who is conversant with the views of educated Mahomedan gentlemen in the Punjab. Colonel Hutchinson traces the universal uprising of the Pathan tribes along the whole line of the frontier to the natural fear of losing their independence, which was roused by the process of

demarcating the "Durand" boundary. It commenced with the commencement of demarcation at Wana; it continued *pari passu* with the process at Chitral; and it ended only when the proposal to divide the Mohmand country in half by an outward and visible boundary line was abandoned.

"And how can we blame these people, simple, savage and unsophisticated as they are? We may explain to them as much as we like, and protest as loudly as we can, but when they see the long line of boundary pillars going up; when they are told that henceforth all inside that line practically belongs to the British *Raj;* and that from this time their allegiance must be to us; and when, finally, they note our surveyors at work, mapping their country, and measuring their fields, their reflection is, 'Methinks you do protest too much!' And they are irresistibly driven to the conclusion that their country is annexed and their independence gone."

It is, indeed, hardly necessary to assume that the Pathan is either "simple" or "unsophisticated" to account for his arrival at this conclusion.

The story of the campaign is well told, and the illustrations, although here and there they betray the sketchiness of the amateur, are on the whole exceedingly effective.

Preliminary Report of an Investigation of Rivers and Deep Ground Waters of Ohio as Sources of Water Supplies. By the State Board of Health. Pp. 259. (Cleveland: J. B. Savage Press, 1898.)

BY an Act of the Legislature of the State of Ohio, U.S.A., it is provided that no city, village, or corporation shall introduce a public water supply, or system of sewerage; or change or extend any public water supply or outlet of any sewage unless the proposed works shall have been submitted to, and received the approval of, the State Board of Health; and by a subsequent Act it was ordered that the Board of Health should examine and report annually on the condition of all public water supplies. The enactment of these laws grew out of the general recognition of the fact that the pollution of streams and lakes by sewage had already reached a point when it had become a menace to public health, and that some intelligent supervision and control of the sources of public water supply had become necessary.

The Board of Health, in order to be in a position to deal in a comprehensive manner with the various schemes submitted for approval, has commenced an investigation of all the sources of supply and of the streams and rivers of the State; maps and statistics have been prepared, showing the principal towns and villages and the sources of water supply and sewage disposal; and a laboratory has been established for chemical and bacteriological examination. The report now issued deals in a very complete and comprehensive manner with the way in which the investigations of the Board are carried out; the methods of analysis, the results of bacteriological examination, reports on gauging, and the merits of different geological formations as sources for water supply. Although confined to the water supply of Ohio, the information given cannot but be of great interest and value to sanitary engineers and chemists engaged in works of a similar character in this country.

The Periodical Cicada. By C. L. Marlatt, First Assistant Entomologist. *Bulletin*, No. 14, New Series. Department of Agriculture, Division of Entomology. (Washington, 1898.)

WE learn from Dr. L. O. Howard's "Letter of Transmissal," prefixed to this Report, that it is intended to replace a former *Bulletin* on the same subject published in 1885. He says that the insect is "distinctly American, and has the longest life period of any known insect. Economically, it is chiefly important in the adult stage from the likelihood of its injuring nursery stock and young fruit trees by depositing its eggs." We are inclined, however, to think that several large wood-feeding insects, such as Longicornes and *Siricidae*, sometimes surpass the *Cicadae* in the length of their life; and one or two *Lepidoptera*, such as *Eriogaster lanestris*, may remain in the pupa state for many years. Among the peculiarities of this *Cicada* are the periodicity of its broods, some appearing at intervals of seventeen years (whence its name), and others at intervals of thirteen years; and the dimorphism of the insect, which constantly exhibits a large form and a small form side by side in the same brood. This periodicity renders it easy to calculate when it will be common in any special locality, according to the number of thirteen-year or seventeen-year broods which may be running their course parallel with each other. Owing to the destruction of forests, however, it is much less abundant than formerly, and is hardly to be reckoned now with really destructive insects. The English sparrow, too, destroys great numbers. W. F. K.

The Brain-Machine: its Power and Weakness. By Albert Wilson, M.D. Pp. vi + 157 + 24 Plates. (London: J. and A. Churchill, 1899.)

MUCH instructive information concerning the structure and mechanism of the brain and nervous system, and the mechanism of thought and mind, is presented in a popular style in this volume. The aim of the author appears to be to show how to preserve the health and integrity of the brain-cell, and to point out the importance of the subject in national as well as individual welfare. The volume should be of assistance to parents and schoolmasters who are concerned with the education of children, for while the author pleads for the cultivation of brain-power, he shows that the *mens sana* requires to be *in corpore sano.*

The Swastika. By Thomas Wilson. Pp. 255. (London: W. Wesley and Son, 1898.)

THIS interesting monograph on the Swastika, prepared by Mr. T. Wilson, Curator of the Department of Prehistoric Anthropology, United States National Museum, appeared in the report of the Museum for 1894, and has already been described in these columns. The Swastika is the earliest known symbol, and the object of Mr. Wilson's memoir is to trace its migrations. The volume contains 374 figures in the text, and 25 plates, including a chart of the geographical distribution of the symbol. Many students of archæology will be interested in the contents.

Dictionnaire Technique Français-Anglais. By A. S. Lovendal. Pp. viii + 158. (Paris: Boyveau et Chevillet, 1899.)

THE French and English equivalents of the names of tools used in various trades are shown in parallel columns in this volume. We have, for instance, the phrase "Étau à tige à mâchoire étroite" as the equivalent of dog-nosed tail vice, and the phrase "Compas double calibre à ¼ de cercle entaille" as the equivalent of egg callipers with groove wing. The volume will be of service to technical students both in France and England, and it will serve to warn translators against the literal rendering of expressions with which they are not familiar.

Incubators and Chicken Rearing Appliances. Pp. xii + 64. (London: Cassell and Co., Ltd., 1898.)

THE chapters on the construction and use of incubators, contained in this pamphlet, originally appeared in the periodical *Work.* They are essentially practical, and may furnish keepers of poultry with useful hints. The references to the natural *heat* of a hen's body as 98° F., and the *heat* at which to work, will be understood by the readers of the pamphlet, but it would have been better to have used the word temperature instead of heat.

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.*]

Prof. Meldola and Mr. Herbert Spencer as Critics.

THREE letters have lately appeared in these columns commenting on my book lately published under the title of "Organic Evolution Cross-examined." Two of these are by Prof. Meldola, and one by Mr. Herbert Spencer. By the first I ought to feel much honoured, because the Professor lays down the law that nobody outside the class to which he himself belongs, namely professional experts, should be allowed to write or be listened to on such subjects as biology. One feels the atmosphere of condescension throughout his ostensible criticism, and he thinks it necessary to excuse himself for taking so much trouble as to criticise it at all. Perhaps he will allow me to explain what my doctrine and practice about experts has always been. It has been to take them frankly for all that they are worth, and that is much. First, I always accept everything they can tell us on matters of fact. Secondly, I always examine closely the language or phrases under which those facts are expressed, to see how far silent assumptions, or artificial conceptions, are imported into the interpretations of the facts of nature. Thirdly, I watch to see how far they set up an artificial vocabulary of their own, having for its object to wipe out of all natural phenomena the highest intellectual conceptions to which they are related. I am sorry to say that I do not know enough of Prof. Meldola's writings to be able to say how they would be found to stand this weapon of analysis. But I am struck by the fact that he seems to attribute to me the application of the word "plan" to organic structures: thus showing, on the one hand, great antipathy to the word; and, on the other hand, complete ignorance or forgetfulness that the word, in that sense, is not mine, but the word systematically used by Prof. Huxley in all his most typical works. This makes me suspect that Prof. Meldola may yield to the very common temptation to manipulate language so as to keep out of sight suggestions of thought which are instinctive but which are dangerous to his own theories and philosophy. I note, also, that in his condescending criticism of my book he deals a good deal in chaff; and when he encounters a fact or an argument not easily dealt with, he rides off in some flippant joke, as in the case of the electric organs of the torpedo and other fishes. Considering that Dr. Romanes thought my argument on those organs so strong, that if there were many other cases in nature of the same kind, he would be obliged to give up the Darwinian theory, it is surely worth the trouble even of so great an expert as Prof. Meldola to give some serious reply.

But I pass from Prof. Meldola to a criticism which concerns me a great deal more—because it comes from Mr. Herbert Spencer, for whose intellectual integrity I have the highest admiration and respect.

In my book I have dwelt at some length on the sad fate which has befallen both the celebrated phrases in which the Darwinian theory has been clothed. I have represented both of them as having come to grief, and as having been exposed to a most destructive criticism at the hands of no less an authority than Mr. Herbert Spencer, himself the author of one of these phrases, and one of the earliest patrons of the other. In this Mr. Spencer thinks I have been unfair to him. Let us hear, then, what he says in explanation.

As regards the phrase "natural selection," Mr. Spencer says that he pointed out that "its metaphorical character is apt to mislead." Exactly so! But how? It is all metaphor together. "Selection" is the idea on which it turns, and in the Darwinian theory there is no selector. But its whole popularity, and the whole possibility of the phrase representing the facts of biological science depended on the analogy of a breeder; and when this element of meaning was abandoned and denounced, nothing remained behind. Men may choose to go on using it, if they like, but as the expression of a systematic theory it is gone.

Well, now, what has Mr. Spencer done with the alternative phrase invented by himself? He says that "kindred objections may be urged against 'survival of the fittest,'" for just as selection suggested a human selector, so did the word "fittest" suggest some fitter. Therefore both phrases were alike metaphors, and both were therefore equally deceptive. There is no fitting, he says, in nature like that of a glove to a hand, or of a key to a lock. I deny this absolutely. But assuming it to be so, then the word should be given up as applied to the marvellous adaptations of structure to functions in organic life. The whole virtue of the phrase is gone. I have not meant to allege that Mr. Spencer himself sees the full effect of his destructive criticism, or that he may not continue to hold by the child of his earlier years for some purposes of literary convenience. But we—the public and the scientific world—have nothing to do with that. What we have a right to deal with is a phrase which has enjoyed a wide popularity, and which has purported to express and to explain correctly the course of development in organic life. We find the author of this phrase admitting that it has in it elements lending themselves to deception, and that it suggests correlations of a kind which have no place in nature. This is to me an abandonment of the phrase, whether the original author of it thinks it so or not. The phrase is no longer his exclusive property. It belongs to the history of philosophy, and the criticisms of its own orginator are among the most valuable helps we have in estimating any value it ever had. Mr. Spencer has now invented another phrase—"the theory of indirect equilibration"—which he represents as equivalent, and with reference to which I venture to predict that it will speedily share the fate of both its predecessors, as only one more attempt to hide out of sight, under the cover of a new and grotesque vocabulary, some of the most salient facts of biological science.

ARGYLL.

IGNORING all personalities, expressed or implied, in the above communication, there are a few points which call for rejoinder. In the first place, the statement that I have laid down the law that none but professional experts should be allowed to write on biological subjects is a complete misrepresentation of my views. I have on more than one occasion made statements in precisely the opposite sense. If I may be permitted to quote from an address to the Entomological Society of London in 1896 (reprinted in these columns), I will invite the Duke of Argyll's attention to the following passage:—"As far as my reading extends, I am inclined to believe that even in the case of the purely literary treatment of biological problems by writers who are not experts, the danger of overweighting the science with hypothesis is much exaggerated. Writers of this class are often capable of taking a wider and more philosophic grasp of a problem than a pure specialist, and ideas of lasting value have sometimes emanated from such sources. I imagine that nobody will dispute that Mr. Herbert Spencer's writings have largely influenced the public mind—whether we agree with the details of his doctrines or not—in accepting the broad principle of Evolution, although this profound thinker lays no claim to an expert knowledge of any branch of natural history. But every working naturalist can ascertain for himself the credentials of any particular writer: my remarks are simply offered with the object of claiming more consideration for such writers, as a class, on the part of practical workers. The philosophic faculty is quite as powerful an agent in the advancement of science as the gift of acquiring new knowledge by observation and experiment. It is not often that the faculties are combined in one individual."

In the next place, it is a misrepresentation to credit me with an antipathy to the word "plan." I have not the least objection to the word or to the idea which it conveys, but I do protest most emphatically against its being introduced by way of an explanation into any branch of science, biological or otherwise. The attempt to make Huxley responsible for the use of the term in this sense is, as I have already pointed out, a misrepresentation of that writer's views.

The paternal insight into the affairs of nature which leads a non-expert writer to put himself into the position of a judge of the value of experts must be a source of immense admiration to the working body of naturalists. I have nowhere laid claim to the distinction of being classed among that body, as my working days in that field are, I am afraid, closed. Nevertheless, I feel duly honoured at the Duke of Argyll's classification of myself with the "experts." Any obscurity under which I may be suffering in the scientific world through the neglect of his Grace to put my writings through his analytical process is, however, relieved—at any rate temporarily—by the invitation of the editor of NATURE to review the book which has given rise to this correspondence. In performing that duty in what I conceive to be the best interest of science, I have preferred to encounter the Duke's views in the open, rather

than under the cover of anonymity. His Grace will, I trust, extend to me at least a small measure of "intellectual integrity" on that score. If the "experts" are to be weighed and measured by some standard of the Duke's creation, then it is obvious that this body of gleaners might reasonably express some kind of opinion as to the value of the treatment to which their facts are being submitted. I have already endeavoured to put forward a plea on behalf of the non-expert philosophical writer, and I have expressly said that naturalists will ascertain for themselves the credentials of each writer. The Duke's contributions have for many years been of a purely destructive order; how far the credentials of a writer who has contributed so little constructively to the edifice of biological science will carry weight with the body of working naturalists is for them to declare.

A few words in conclusion as regards the electric organs of the torpedo. I am the last person to ignore the difficulties in the way of the theory of natural selection. Perhaps I have more faith than my late lamented friend Dr. Romanes in the power of a theory which explains so much being able, when we know more about them, to meet such cases as these; but this is a purely personal matter. The particular difficulty in question, like most others of weight, was long ago suggested to Darwin himself, and was discussed in the "Origin of Species" (6th ed., p. 150). It was discussed also in a letter to Lyell in 1860 ("Life and Letters," vol. ii. p. 352). But if the whole theory of natural selection were to break down on such a difficulty, the doctrine of a "preconceived plan" would not help us in the least. It would not be a philosophical explanation, but, with the very greatest deference to my noble antagonist, a pseudo-philosophical explanation, and, as such, I have felt, and always shall feel, it my bounden duty to science to warn the public from attaching any serious importance to it. R. MELDOLA.

The British Museum Catalogue of Birds.

MY attention has been drawn to some inaccuracy (no doubt unintentional) in the historical account of the production of the Catalogue of Birds given in a recent number of NATURE. Will you, therefore, kindly allow me to correct that account?

At the time of Mr. Bowdler Sharpe's appointment (September 1872) to an assistantship in the Zoological Department of the British Museum, the Keeper of the Department, Dr. Gray, was in so feeble a state of health (consequent on a paralytic stroke) that the administration of the Department had devolved upon Dr. Günther holding the post of assistant-keeper. During the preceding period of his assistant-keepership, Dr. Günther had gone through the whole collection of birds, and formed the opinion that a descriptive catalogue on the lines of his own Catalogue of Fishes ought to be prepared for publication. With this object in view Dr. Günther recommended to the Trustees the appointment of Mr. Sharpe, who, on account of his enthusiasm, energy and general ornithological knowledge, seemed to be specially qualified to undertake the catalogue. Dr. Gray gave his ready consent to the preparation of the catalogue, and the Trustees sanctioned the publication when the MS. of the first volume was laid before them in 1874. Thus, although it is the fact that the preface to the first volume was signed by Dr. J. E. Gray, yet the plan of the work was initiated and elaborated by Dr. Günther, and the work was, during its progress, kept under his constant supervision.

E. RAY LANKESTER.
Director of the Natural History Departments
February 1. of the British Museum.

Queries on the Reduction of Andrews' Measurements on Carbonic Acid.

TO begin with, let me quote a few passages from Andrews' paper. On pp. 301–302 of his "Scientific Papers" he says: "I have not attempted to deduce the actual pressure from the observed changes in the volume of the air in the air-tube. For this purpose it would be necessary to know with precision the deviations from the law of Mariotte exhibited by atmospheric air within the range of pressure employed in these experiments. . . . It will be easy to apply hereafter the corrections for true pressure when they are ascertained, and for the purposes of this paper they are not required. The general form of the curves representing the changes of volume in carbonic acid will hardly undergo any sensible change from the irregularities in the air-tube; nor will any of the general conclusions at which I have arrived be affected by them. It must, however, always be understood that, when the pressures are occasionally spoken of, as indicated by the apparent contraction of the air in the air-gauge, the approximate pressures only are meant."

In every one of his papers specially devoted to the subject he was careful to mention the fact that he was unable to give the true pressures which correspond to the indications of the air- or hydrogen-manometer. The question seems to have hung constantly upon the mind of the experimentalist in the course of his investigations. In spite of this, however, the values of pressure given by him have often been treated as if they were the true values, and in the discussions of the characteristic equation of carbonic acid, agreement or disagreement to within 1/10 of an atmosphere is spoken of. But according to Amagat's measurements on air, hydrogen, or nitrogen, the corrections to be applied are quite large.

In a paper in the *Philosophical Magazine*, vol. xxiii., fifth series, Ramsay and Young have tried, on the basis of Andrews' experiments, to show that in the case of carbonic acid there holds good very approximately the constant volume relation that the pressure under this condition varies linearly as the temperature. They state that they have reduced to absolute units, as far as possible, the values of pressure given by Andrews by means of Amagat's experiments on air. These latter experiments were made at 16°, while the temperature of Andrews' manometer varied within a considerable range, from 5° to 15°. Is the influence of temperature on the manometric correction negligible when the pressure is high? I can show in the case of nitrogen, on the basis of Amagat's experiments, that this auxiliary correction due to temperature variation is generally quite large, sometimes of the same order of magnitude as the main correction itself; and it seems very improbable that in this respect air would differ very much from nitrogen.

The same remark applies to the calculations of Margules (*Wien. Sitzbech.*, xcvii. 2*a*, 1888), and also to my calculations relating to Andrews' measurements on the mixtures of nitrogen and carbonic acid (*Phil. Mag.*, vol. xxxvi. 5th series).

Another point which has for a long time remained a query to me, is the level difference of the mercurial columns in the air and carbonic acid tubes. Let me again quote from Andrews' paper. On p. 303 of his "Scientific Papers" he says: "Having thus ascertained the volumes of the air and of the carbonic acid before compression, at 0° and 760 millims., it was easy to calculate their volumes, under the same pressure of 760 millims., at the temperatures at which the measurements were made when the gases were compressed, and thence to deduce the values of the fractions representing the diminution of volume. But the fractions thus obtained would not give results directly comparable for air and carbonic acid. Although the capillary glass tubes in the apparatus communicated with the same reservoir, the pressure on the contained gases was not quite equal, in consequence of the mercurial columns, which confined the air and carbonic acid, being of different heights. The column always stood higher in the carbonic-acid-tube than in the air-tube, so that the pressure in the latter was a little greater than in the former. The difference in the lengths of the mercurial columns rarely exceeded 200 millims., or about one-fourth of an atmosphere. This correction was always applied, as was also a trifling correction of 7 millims. for a difference of capillary depression in the two tubes." In another place (p. 422) he says: "The pressure in atmospheres, as indicated by the air-manometer, on the gas in the carbonic-acid-tube was given by the equation

$$p = \frac{V_0(1 + \alpha t)}{V_1} \mp \frac{q}{760},$$

in which V_0 is the volume of the air at 0° and 760 millimetres, V_1 the observed volume at the temperature t, and q the difference of level (corrected when necessary for difference of capillary depression) of the surface of the mercury in the manometer and carbonic acid tubes."

Thus what is given as δ or p in Andrews' papers includes in itself the level difference q, and what is really required in calculating the corresponding manometric correction is V_1; q is not given in Andrews' papers. The manometric corrections, then, which are based on the given values of p alone, will differ from what they ought to be by something like ¼ of an atmosphere.

Thus one will find himself prevented from entering upon a

strict reduction of Andrews' measurements at two points, namely, the different temperatures of the manometer and the level difference q. The former might be supplied by making fresh accurate investigations, but will the latter always remain something to be longed for?

The same remark seems to apply to the published results of experiments by Janssen on nitrous oxide, and by Roth on carbonic acid, aethylen, sulphurous acid, and ammonia.

Imperial University, Tokyo, Japan. K. TSURUTA.

THE letter above was sent to me some time ago with a request that I should forward it to NATURE after making inquiries as to the possibility of obtaining, from the laboratory books of Dr. Andrews, the desiderata which Prof. Tsuruta points out.

I am delighted to find that one so well qualified is ready to undertake the labour of the necessary reductions; and I will prepare for publication the data required for the purpose. A recent inspection of the Note-books has shown me that they contain the complete details of the *experimental* part of Dr. Andrews' great investigation.

The work is by no means one of mere transcription; it requires great care, and therefore cannot be done in a hurry.

Edinburgh, January 18. P. G. TAIT.

Fourier's Series.

THE difficulty referred to by Prof. Michelson in NATURE of October 6, 1898, and in subsequent letters, to that in your issue of January 19, involves a disregard of the distinction which it is necessary to make between a quantity which, however small it may at first be taken, is thereafter to be kept fixed, and a quantity which can be or is absolutely zero. To this distinction there is the analogous one between a quantity which is arbitrarily large but still considered as limited, and a quantity which is entirely unbounded.

The question considered by Prof. Michelson, interesting as it is, whether the limit, when n increases indefinitely, of the quantity

$$f(\epsilon, n) = \sin\epsilon + \tfrac{1}{2}\sin 2\epsilon + \ldots + \frac{1}{n}\sin n\epsilon,$$

wherein $\epsilon = k\pi/n$ (k fixed and $< 2n$), is $k\pi$, is not really pertinent as a criticism of the usual statement that the sum of the series

$$f(x) = \sin x + \tfrac{1}{2}\sin 2x + \ldots + \frac{1}{n}\sin nx + \ldots \text{ to } \infty$$

is $\frac{1}{2}(\pi - x)$ when $0 < x < 2\pi$ and is 0 when $x = 0$; to get the sum of such a series it is always to be understood (i.) that we first settle for what value of x we desire the sum, (ii.) that we then put the value of x in the series, (iii.) that we then sum the first n terms and find the limit of this sum when n increases indefinitely, *keeping x all the time at the value settled upon*. In the function $f(\epsilon, n)$ above, this condition is not observed; as n increases indefinitely, $\epsilon = k\pi/n$ does not remain fixed, but diminishes without limit. A similar convention is to be observed in other cases. For instance, when a function of x is defined by a definite integral taken in regard to a variable t, the variable x entering as a parameter in the subject of integration; the value of the function is then always to be found under the hypothesis of a specified value for x, which is to be substituted in the subject of integration before the integration in regard to t is carried out. Or, again, in such a common operation as finding the differential coefficient; for instance, we have

$$\frac{d}{dx}\left(x^2\cos e^{\frac{1}{x}}\right) = 2x\cos\left(e^{\frac{1}{x}}\right) + \sin\left(e^{\frac{1}{x}}\right).e^{\frac{1}{x}}$$

which is indeterminate when $x = 0$; but the differential coefficient of $f\left(x\right) = x^2\cos\left(e^{\frac{1}{x}}\right)$ at $x = 0$, is not indeterminate; for we have

$$\lim_{h=0}\left[f\left(0+h\right) - f\left(0\right)\right]/h = \lim_{h=0}\left[h\cos\left(e^{\frac{1}{h}}\right)\right] = 0.$$

Another point involved is that a function may continually strive to a limit and yet not reach it. For instance, consider

$$\phi(x) = x^2 + \lim_{n=\infty}\left(1 - x^{\frac{1}{n}}\right),$$

where it is understood that we are to obtain the value of $\phi(x)$ for any specified values of x by first substituting this value of x on the right side, then calculating the successive values of $1 - x^{\frac{1}{n}}$ for successive finite large values of n, and noticing the limit towards which these values approach indefinitely. When x has any small *specified and fixed* value, however small, it follows, since the limiting value of $\frac{1}{n}$ is 0, that $\phi(x) = x^2$; but when $x = 0$, $x^{\frac{1}{n}} = 0$, and $\phi(x) = 1$. The function thus continually strives to the value 0 as x approaches 0; but it does not reach this value (see also Gauss, "Werke," iii. p. 10). Unless I mistake Mr. Hayward's letter of January 19, there is a similar point there involved. The point P (in the sixth line of his letter from the bottom) strives to the point $\left(\pi, \frac{\pi}{2}\right)$; in the sense in which the sum of a Fourier series is understood, it does not reach this point.

The discontinuity of the sum of the Fourier series considered above is explained by the fact that as x is taken near zero the convergence becomes indefinitely slow; the sequence of values of n necessary to make $s - s_n$ of assigned smallness has infinity for (an unreached) upper limit.

I should be glad to take this opportunity of referring to a point intimately connected with the considerations above, in regard to which most of the accounts in the text-books appear capable of more definiteness. The condition[1] that a sequence of finite qualities $s_1, s_2, \ldots, s_n, s_{n+1}, \ldots$ should tend to a limit is that for any specified small ϵ it be possible to find a finite m, such that for $n > m$ and *for all values of p* the absolute value of $s_{n+p} - s_n$ should be less than ϵ. The question may be asked: Does *all values of p* mean only all finite values however great (arbitrarily or indefinitely but not infinitely great), or is the value $p = \infty$ supposed to be required. There is no doubt the phrase may be limited to mean *all finite values of p, however great*. Thus taking the function $\phi(x)$ above, and putting, what is in accordance with the condition as now stated, $s_n = \phi\left(\frac{1}{n}\right)$, the sequence of quantities $\phi\left(\frac{1}{n}\right)$ defines a value, namely zero, which we may quite fairly describe as the limit of the sequence. Though we may also say, in a certain sense, that this limit is not reached; in fact, the value s_∞, regarded as $\phi(0)$, is 1. And, further, the series

$$u_1 + u_2 + u_3 + \ldots$$

wherein

$$u_1 = 1,\ u_n = \phi\left(\frac{1}{n}\right) - \phi\left(\frac{1}{n-1}\right)$$

is convergent, and its sum is the limit of the sequence $s_1, s_2, \ldots, s_n, \ldots$, namely zero; and this notwithstanding that $s_\infty = 1$. A more striking case is got by replacing $\phi(x)$ by

$$\psi(x) = x^2 + \lim_{n=\infty}\left(1 - x^{\frac{1}{n}}\right),$$

The phraseology is analogous to the usual one for a definite integral; for instance, the integral

$$\int_\zeta^x \frac{dx}{x[\log x^{-1}]^{1+\sigma}},$$

wherein x is less than 1, and σ is positive, has a definite limit when $\zeta = 0$; for whatever assigned value ϵ may have, it is always possible to find a positive value for ζ, such that for any positive value of ζ_0 less than ζ the integral

$$\int_{\zeta_0}^{\zeta} \frac{dx}{x[\log x^{-}]^{1+\sigma}}$$

is numerically less than ϵ. This statement is, however, made with the proviso that ζ_0 is not to be taken zero or infinitely near to zero, though it may be taken as small as we please; it is indefinitely small without being infinitely small. If ζ_0 were taken zero, the last integral would, strictly, be meaningless.

If only for the purpose of showing that the notion of an

[1] See, for instance, the excellent book of Harkness and Morley, "Introduction to Analytic Functions" (January 1899; Macmillan and Co.), which is surely unequalled for the matters of which it treats.

unattained limiting value is not new-fangled, it appears worth while to quote a few words of the paper of Gauss, above referred to, which is of date 1799.

"Ex suppositione, X obtinere posse valorem S neque vero valorem Π, nondum sequitur, inter S et Π necessario valorem T jacere, quem X attingere sed non superare possit. Superest adhuc alius casus: scilicet fieri posset, ut inter S et Π limes situs sit, ad quem accedere quidem quam prope velis possit X, ipsum vero nihilominus nunquam attingere."

It is a curious enough fact of history that it is Weierstrass's use of this principle which has destroyed the Dirichlet proof of a fundamental theorem of the theory of potential (Thomson and Tait's "Natural Philosophy," 1879, vol. i., first line of p. 171). H. F. BAKER.

Cambridge, January 23.

The Aurora of September 9, 1898.

I OBSERVE, from NATURE, that an auroral display was visible in the South of England on the evening of September 9. It may interest some of your readers to know that an aurora was seen here on the evening of September 10. The display began at about a quarter to eight o'clock, and lasted for an hour or so. The whole southern heavens at first became suffused with a bright orange light low down upon the horizon, from which a few streamers issued from time to time, rising (judging by the eye) to a height of, say, 45 degrees above the horizon. When both glow and streamers had faded away, I noticed three luminous clouds, one at the zenith. The largest of these clouds increased in size, and shot forth a few streamers of light, both upwards and downwards, and all then disappeared. I have witnessed several auroral displays at Ashburton, but none like that of September 10, the distinguishing features of which were the orange glow and the luminous clouds.

On the following day, my telephone, which had never failed me before, worked irregularly, and some of the other telephones in the town were similarly affected. CHAS. W. PURNELL.

Ashburton, Canterbury, N.Z., December 21, 1898.

THE APPLICATION OF PHOTOGRAPHY TO THE STUDY OF THE MANOMETRIC FLAME.

THERE are few more beautiful phenomena in experimental physics than those presented by the image of the manometric flame as one sees it in the revolving mirror. Especially is this true when the flame is excited by means of the complex tones of the human voice or by some musical instrument such as the violin, which possesses pronounced and varying tone colour.

Little use, nevertheless, has been made of the flame as an implement in research. Indeed the whole of the early literature pertaining to the manometric flame may be said to consist of the three papers[1] in which, at intervals of ten years, Rudolph Koenig described the apparatus which he first made public at the London Exhibition of 1862, together with the various experiments to which it was adapted. The writers of text-books, it is true, have made free use of Koenig's beautiful method, but investigators have been slow to avail themselves of it. The use of sensitive flames in the stroboscopic study of vibrations by Toepler (*Poggendorff's Annalen*, vol. cxxviii. p. 108, 1866), which method has since been employed by Brockmann (*Wiedemann's Annalen*, vol. xxxi. p. 78, 1887) in his analysis of the movement of the air in organ-pipes, and also the observations of singing and of sensitive flames by Kundt (*Poggendorff's Annalen*, vol. cxxviii. p. 337 and p. 614, 1866); by Barrett (*Philosophical Magazine*, 1867); and by Tyndall ("On Sound," Lecture vi., 1867), belong to this period. These researches, however, form a class by themselves, and are to be traced back to the earlier work of Higgins (1777), Chladin (1802), De la Rive (1802), Faraday (1818), Wheatstone (1832), Schaffgotsch (1857), and Le Conte (1858). In them the use of the manometric capsule does not occur, and they appear, from first to last, to be entirely independent of the work of Koenig.

The difficulty of securing a trustworthy record of the forms taken on by the flame-image has doubtless had much to do with this hesitancy. The drawings published by Koenig to accompany the description of his experiments are of great beauty, and the more intimately one is acquainted with the appearance of the flame-image itself, the more one is impressed with the extraordinary fidelity of these representations of it. The secret of their accuracy is to be found in the method by which they were obtained, which is described by Koenig in the article of 1872, to which reference has already been made. In the preparation of the well-known plate of the drawings of flame-images corresponding to the five principal vowel sounds, which was exhibited at the annual meeting of German Men of Science (*Naturforscherversammlung*, Dresden, 1868) each vowel was sung at a carefully ascertained pitch, and duplicate drawings were made by Koenig himself and by a draughtsman employed for that purpose. When these two drawings were found to be alike they were assumed to be correct, but wherever a variation occurred the experiment was repeated until the two were brought into agreement. Each vowel was sounded with a pitch corresponding to each note of the scale between ut_1 and ut_3, so that seventy-five of these drawings, perfected by many repetitions, appear in this one plate.

The most complicated of the pictures of the manometric flame drawn by Koenig is that shown in Fig. 1,

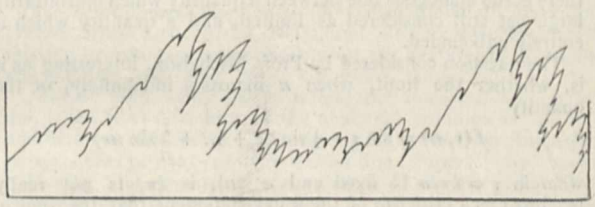

FIG. 1.—Drawing of a manometric flame (after Koenig).

in which an attempt is made to record the motions of the flame when the tongue is going through the vibrations necessary to produce the rolling sound of the German *r*, but without permitting the vowel-producing qualities of the voice to accompany it. Doubtless the difficulty of securing records by the method of free-hand sketching, which had been employed by Koenig, to say nothing of the difficulty of interpreting the more complicated forms assumed by the flame-image, has prevented the general introduction of what in other respects is a very attractive method of research.

In 1886 the question, which must have occurred to many observers of the manometric flame, whether these fleeting flame-images could be photographed, was answered affirmatively by Doumer (*Comptes rendus*, vol. ciii. p. 340; vol. cv. p. 1247), who used such photographs in the determination of pitch and of the phase relations of sound waves. Doumer, however, published none of his photographs; so that we do not know what degree of success he attained. In 1893 Merritt, who was at that time unacquainted with Doumer's experiments, undertook the photography of the manometric flame in the hope of thus developing a method which would be of use in connection with certain studies in phonetics. His paper, entitled "A Method of Photographing the Manometric Flame, with Applications to the Study of the Vowel A" (*Physical Review*, vol. i. p. 166), contains the first published photographs of the Koenig flame-images. Merritt found it barely possible to photograph, upon a rapidly moving plate, the flame produced by the ordinary Koenig apparatus. The actinic weakness of the flame

[1] Koenig: *Poggendorff's Annalen*, vol. cxxii. p. 242; vol. cxlvi. p. 161; "Quelques Expériences d'Acoustique," Chapter vii.

was such that the development of the under-exposed plates was exceedingly laborious, and the results were most unsatisfactory. He turned his attention, therefore, to increasing the actinic effect by the use of a burner in which the flame, at first of ordinary illuminating gas, was surrounded by pure oxygen. With this form of burner, a diagram of which is given in Fig. 2, photographs were readily obtained upon a moving plate, in which the salient features of the images described by Koenig were clearly brought out. The gas was subsequently enriched by passing it through a receiver of petroleum ether, and in this way the brilliancy of the flame was further greatly increased. In Merritt's experiments the moving plate was shot horizontally through the field of the camera at a speed sufficient to separate properly the various flame-images. The speed of the plate-holder, which was arranged to slide between guides, was about two metres per second. The entire time-period covered by the chrono-photographs thus produced was only a few hundredths of a second.

Chrono-photographs of the manometric flame have since been made by Hallock and Muckey (*The Looker On*, 1896, pp. 1, 177 and 375, 1896), who used such flames, excited by resonators, in the analysis of the voices of various opera singers; by the writer in collaboration with Prof. Merritt (*Physical Review*, vol. vii. p. 93, 1897),

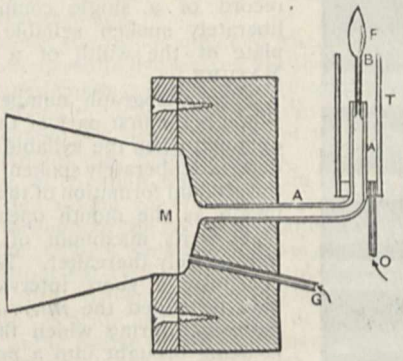

FIG. 2.—Merritt's burner [the diaphragm is at M; illuminating gas enters at G; oxygen at O].

and by Miss J. A. Holmes (*Thesis*—in manuscript—Library of Cornell University, 1898).

Acetylene gas, which has come into common use since the experiments just described were made, affords a light of much greater actinic power than any which was formerly available. The flame of burning magnesium alone surpasses that of acetylene in brilliancy. The carbon bands in the electric arc, to be sure, give that source of light, likewise higher actinic value than the acetylene flame; but the arc light cannot be used manometrically, nor, indeed, is it probable that the magnesium flame could be thus employed.

When we surround the acetylene flame with pure oxygen in a burner, like that described by Prof. Merritt, its actinic power is still further increased.

In 1897 the writer spent many pleasant hours of the summer vacation with Prof. Merritt in the fascinating work of photographing the manometric flame. The experiments of 1893 were repeated with acetylene in place of ordinary enriched burning gas, and with films of considerable length instead of the glass plates. The manometric burner was the same in all essential features as that described by Merritt in the article which I have just cited. It was supplied with a mixture of equal volumes of acetylene gas, generated by the action of water upon calcium carbide in the usual manner, and of hydrogen. The chrono-photographs were taken upon films 120 cm. in length, which for convenient handling were mounted in an especially constructed camera. This camera consisted of the usual lens and bellows, and of a rectangular box of wood containing a drum D (Fig. 3), upon the periphery of which the film was mounted. The drum could be driven at a convenient speed, either by means of a belt attached to an electric motor, as shown in the diagram, or, as was sometimes found to be more convenient, by hand. The box which contained the drum was light-tight, excepting that at a position suitable to allow the passage of the rays from the lens there was a vertical slit closed by a shutter. This shutter could be opened electrically by an observer stationed at the manometric flame, after which it remained open for precisely one revolution of the drum. When this revolution was completed, the shutter closed automatically.

The revolving drum, which carried the sensitised film upon which the photographs of the flame were taken, was given a speed in most of our experiments of about one revolution per second. This was found to be quite sufficient for the proper separation of the flame-images. and it permitted us to record upon a single film any word or phrase the utterance of which did not require more than a second of time. In certain cases, where we desired to include in the chrono-photograph poly-syllabic words or phrases, the speed was somewhat reduced; in other cases, for the purpose of a further separation of the flame-images, the drum was driven at a much higher velocity.

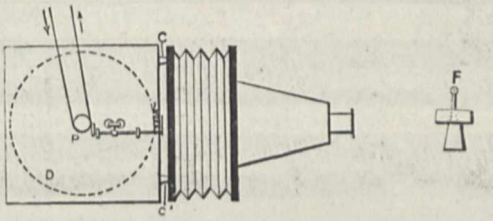

FIG. 3.—Camera for photographing the manometric flame. [The flame is at F; the revolving drum is represented by the dotted circle D.]

In the manner just described a large number of striking photographs were obtained, the beauty and sharpness of detail of which no adequate idea can be given in the printed reproduction. It was found that the repetition of the same combination of articulate sounds, uttered at the same pitch and by the same speaker, always gave very closely indeed the same series of flame-images. Nevertheless the reading and interpretation of these photographic representations of the manometric flame is by no means a simple matter. When we attempt to read such a record, as one would read the trace of the syphon recorder in a telegraphic message, or as one would read shorthand, we find that it is only the vowels which produce any marked agitation of the flame. All those accompanying mouth-sounds which introduce and close each syllable in articulate speech, and by which, in great measure, we are able to distinguish the different words, produce a very feeble and often an unrecognisable effect upon the flame. The records are indeed the very opposite of shorthand writing, not only in that instead of a single character to a syllable, we have sometimes as many as a hundred oscillations of the flame, but likewise in the fact that while shorthand is made up of words with the vowels left out, these manometric photographs represent speech with the consonants suppressed. It is obvious that to read a record of the latter sort, even after the eye had been trained to recognise the flame-groupings characteristic of all the vowel sounds, is more difficult than it is to pick out words in which the consonants are indicated and the vowels omitted.

There is in the interpretation of the flame photographs

a further difficulty which is clearly brought out in the famous chart of drawings exhibited by Koenig in 1867. This difficulty is due to the fact that the characteristic grouping for each vowel differs with the pitch at which the sound is uttered, and that no two speakers sound the vowels in precisely the same manner, each one having his personal peculiarities of voice. Fortunately it is not necessary to learn to read them in this way, since their interest lies chiefly in the completeness with which they serve to show a multitude of details and peculiarities of articulate speech, which cannot be so directly studied in any other manner.

Not only are the subtle differences which distinguish the vowel sounds uttered by persons speaking various dialects manifested by differences in the flame groupings, but, as I have just pointed out, the individual peculiarities in the utterance of different speakers using the same dialect are plainly discernible. We have, moreover, in the record of each individual syllable, most interesting evidence of the gradual formation of the full vowel sound as the mouth opens at the beginning of the syllable, and the modification of the sound again as the mouth closes at the end. Another peculiarity which the reader of the manometric records encounters, lies in the fact that the pauses between words in ordinary speech are often of no greater duration than pauses between syllables of the same word. There is thus no way of separating words from one another until the record has been interpreted, and each group of flame-images has been assigned its place in the phrase. This difficulty is akin to the one with which we meet when, with unaccustomed ears, we try to distinguish for the first time the spoken words of a foreign language. The flame record does, on the other hand, for the reader what the printed page does not do. It shows clearly by means of the strength of oscillation into which the flame is thrown, which syllables are accented and which are unaccented by the speaker; and more than this, it is capable of indicating the degree of emphasis placed upon each syllable, and of recording faithfully those only too numerous cases in which we slur over, in careless speech, portions of a word which should perhaps be clearly enunciated.

It is unfortunately not possible to illustrate these points of interest without the use of very large plates. To show properly the record of a word or phrase containing four syllables, the photograph must be at least one metre in length. It is only possible to clip here and there an interesting passage from the records by way of illustration of the appearance of the photographs which may be obtained. These passages are of necessity very brief, covering a time interval in each case of less than two-tenths of a second. One cannot even give the record of a single complete, deliberately spoken syllable upon a plate of the width of a page of NATURE.

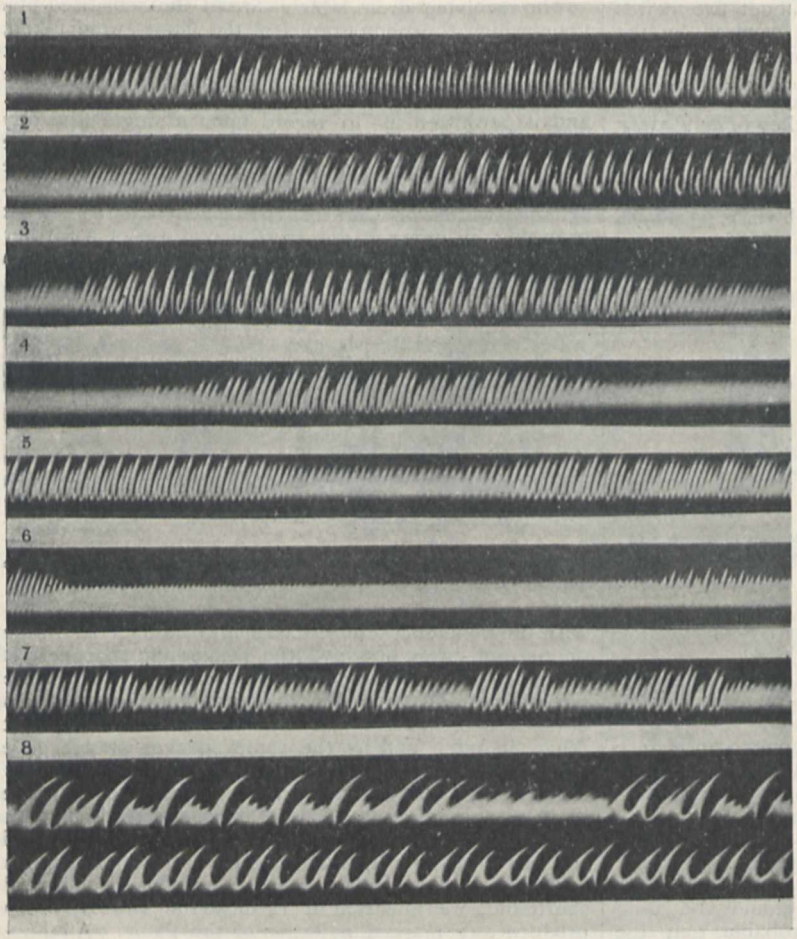

FIG. 4.—Specimens of chrono-photographs of the manometric flame. [The original width has been reduced by one-third.]

The photograph numbered 1 in Fig. 4 is the first part of the record obtained when the syllable *dă* (as in dart) is deliberately spoken. It shows the gradual formation of the serrated image as the mouth opens, which reaches its maximum of strength immediately thereafter. This is followed by a short interval, which may be called the *interval of adjustment*, during which the mouth is being brought into a position to utter the vowel properly. At the extreme right-hand the first vibrations due to the fully-developed vowel sound are to be seen. This photograph gives about one-third of the complete record obtained from such a syllable.

No. 2 shows in like manner the formation of the syllable *ah*, deliberately spoken, in which the mouth opens more slowly and the formation of the vowel is preceded by a characteristically different set of flame groupings. This trace is likewise cut off for lack of space, so as to show only the first third of the syllable.

No. 3 shows the whole of an accented syllable in a rapidly spoken word. The word in this case was *preposterous*, and the syllable selected for illustration here is the antepenultimate *pos*.

No. 4 shows a syllable still further shortened by rapidity of speech, namely *tan* at the end of the word *Raritan*.

No. 5 is a small portion cut from the middle of the record obtained from the word *river*. It is introduced into the plate for the purpose of showing the partial interruption of the vibrations due to the sounding of the *v* in the middle of this word. It is interesting to note likewise the gradual modification of the vowel sounds before and after *v* as the mouth closes and opens again.

The interruption due to this consonant is probably the least marked of any. The pronunciation of *b*, *d*, *t* and other consonant elements in the middle of words usually causes a more or less complete cessation of oscillations on the part of the flame for a considerable period of time.

No. 6 shows the record for the ending of the word *doctor*, spoken hurriedly. The photograph shows the behaviour of the flame from the moment when the first vowel sound is just being cut off by the closing of the mouth for the enunciation of that portion of the word represented by the letters *ct*. The whole of the last syllable, which is almost completely suppressed and slurred over, as is too often the case in every-day speech, is shown. The period of quiescence in this instance is greater than that which takes place between the successive words of a sentence spoken in the ordinary manner. This peculiarity has already been referred to in a previous paragraph.

No. 7 is a portion of the photographic record of the word *Raritan*, comprising the closing vibrations due to the first vowel sound *a* and the transition of this into the form of the rolling *r* which follows. The letter *r* was given a much stronger roll in speaking this word than is customary in English, for the purpose of studying the flame record thus obtained. Each contact of the tongue to the roof of the mouth in the production of the trill is shown in the flame record by a partial blotting-out of the serrated image.

No. 8 shows the results obtained when the speed of the film was increased to five metres per second. The upper line of flame-images is that obtained from a continuously sounded rolling *r*. It is possible in this instance to show only the details of a single member of the series of trills which make up this complex sound. The lower record, which was taken upon the same film and at the same speed, is that of the vowel *a* flat (as in cat) continuously sounded throughout the entire revolution.

It is the writer's opinion that very interesting and possibly important results might be obtained by the use of longer films driven at even higher rates of speed. There are indications, in certain of the photographs obtained in the course of the experiments just described, of vibrations of higher pitch, which are not properly separated from one another even at the speed of five metres per second.

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THE STUDY OF TROPICAL DISEASES.

THE *Geographical Journal* for December contains an interesting monograph, by Dr. Wistenra Sambon, upon the acclimatisation of Europeans in tropical lands. The subject-matter of this paper was discussed at the Royal Geographical Society last April, and various opinions were expressed upon it. Dr. Sambon is, further, the author of other communications dealing with this question. Put briefly, his contention is that there is nothing inimical to Europeans in tropical climates which cannot be prevented by hygienic measures. The two main characteristics of the tropical climate, viz. heat and moisture, are practically never *per se* the cause of disease, nor do they *per se* cause any deterioration in either the colonists themselves or their progeny. The mass of the so-called diseases of tropical climates has a parasitic origin. The enormous number of deaths from malaria in the unhealthy regions of Africa, and from snake-bite in India, are quoted by the author as examples of this. Even heat-stroke is, according to him, of parasitic origin. Further, not only is the great enemy to colonisation after actual occupation, the microbe, but the same agency comprises the great difficulty in colonisation. For instance, in the French Expedition to Madagascar in 1896, only seven men were killed by Hovas, and ninety-four wounded; the deaths due to pathogenic micro-organisms numbered 6000, and the sick list from the same cause 15,000. From these facts the contention is that all we have to do in order to make Europeans thrive in the tropics, is to exterminate the pathogenic micro-organisms which are the cause of so-called tropical disease; these once subjugated, and Europeans could live in the tropics like natives.

How this is to be done is naturally the difficulty. In the case of the malarial parasite, for instance, should we set about producing immunity, or destroying the parasite in the most exposed phase of its life-history? The latter method is the one which recommends itself as being, if the most difficult, at the least the most radical; hence the importance of the minute study of the life-history of each pathogenic parasite.

To render Europeans capable of supplanting natives in tropical countries is more, as Sir Harry Johnston pointed out, than we want. The desideratum is to render a relatively small number of Europeans capable of ruling the tropics. The limited knowledge we now possess of the means of curing tuberculosis, and of exterminating the tubercle bacillus, even although some of our best workers and thinkers have devoted themselves to the subject for more than a quarter of a century, prevents the most sanguine of us from expecting that the means of exterminating the malarial parasite will be hit in the immediate future. In spite, however, of this, no one can legitimately doubt that the careful study of the life-history of the parasite, and the nature of the so-called predisposition to malaria, will avail much in lowering the European death rate in the malarial regions of the tropics.

In this connection, it is interesting to note that there will, before long, be established in London an institution for the study of tropical disease. This institute will have a double function, viz. education and research. Use will be made of the clinical material of the port of London for teaching qualified medical practitioners who, either as members of the Government services, or as private individuals, intend practising in the tropics. In addition, research work upon the nature and causation of tropical disease will be undertaken and encouraged. The founding of this institution, as is invariably the case, has not been free from difficulties. Some of these, if not all, are probably by this time well known to the public, as, after a preliminary statement of grievances in the medical press, a lively correspondence has been devoted to this subject in the *Times*.

The site of the institute has been fixed at the branch hospital of the Seamen's Hospital Society, between the Royal Victoria and the Albert Docks. Upon the school buildings and enlargement of the hospital 13,000*l*. is to be spent, towards which the Colonial Office contributes 3350*l*. The maintenance of the school and the additional beds is estimated at 3050*l*. per annum, of which 1000*l*. will be paid annually by the Colonial Office in fees for the instruction of its students. The curriculum to be followed at the schools is to be arranged by a committee of experts.

The opposition to the scheme chiefly arises from three sources. The established medical schools, or rather their representatives, say that, both with regard to clinical material and laboratory accommodation, there is no need to go to the expense of building and instituting a new school. The staff of the Dreadnought Seaman's Hospital, of which the hospital which is to be metamorphosed into the new school is a branch, agree in the main, and emphasise the incongruity of choosing a relatively small hospital to the exclusion of the parent hospital and its staff. A third class of opposition, which may be described as unattached, appears in the form

of Mr. Hutchinson, who has written a powerful letter to the *Times*. In this letter he sets forth how easy it would be to arrange to use the clinical material at the docks in connection with an institution which is at present appealing to the public for funds, viz. the Post-Graduate Medical Polyclinic in Chenies Street, Gower Street. Mr. Hutchinson points out that lectures will probably be delivered at the Albert Docks by professors living in the immediate neighbourhood of Harley Street, and be listened to by students living in the neighbourhood of Gower Street; hence much time will be lost both by teachers and taught, who could obviously come together, for everything except actual bed-side teaching, upon more convenient premises, viz. those of the Post-Graduate College. On the other hand it is contended, on the part of the promoters of the Home Secretary's scheme, that what is required is a school entirely devoted to the study of tropical medicine, where students shall do nothing else, and shall give their whole time to this branch of medicine. It cannot be denied that living in the atmosphere of a subject is greatly conducive to the quick acquisition of a knowledge of it. How this result is brought about is not quite so clear; it seems to be a kind of intellectual osmosis. Apparently what the Home Office want is to run their candidates quickly through somewhere where they can quickly gain a good knowledge of tropical medicine, and be then able to materially aid colonisation. They do not want the time of their candidates wasted in going here for lectures, there for clinical cases, and somewhere else for bacteriology. Whether the extra expense involved in concentrating all the requisites for this special education under one roof will be money spent to the greatest advantage from the point of view of general medical education, is perhaps questionable. The scheme will, however, appeal to the commercial and philanthropic interests involved as business-like, and will probably receive their support. It is to be hoped that neither the local interests of medical cliques on the one hand, nor the colossal dignity of the College of Physicians on the other, will prevent the whole medical profession co-operating to the attainment of a thorough knowledge of tropical medicine by all those who intend to be concerned in its practice.

SOILS FOR ARTIFICIAL CULTURES.

AN increasing amount of experimental work on the growth of plants is being done by means of cultures in artificial soils. It is quite clear that the success of investigations so conducted must largely depend on the perfect suitability of the soil for the production of a full and normal growth. Little attention is, however, frequently given to this point. It is, in fact, often assumed that a pure quartz sand watered with a nutritive solution supplying phosphates, sulphates and chlorides, of potassium, calcium, magnesium and iron, is a fit and proper soil, and that any deficiency of luxuriance in plants grown in such a medium is due to some special circumstance unconnected with the general conditions of the experiment.

Whether some plants are capable of reaching a fair development when placed under the conditions just described is hardly the question; the point on which I wish to lay stress is that such a soil is in several respects a most unnatural medium for plant growth, and is thus generally unsuited for purposes of investigation.

The salts just named are often spoken of as constituting a "full mineral supply," and the conditions described are reckoned as quite suitable for the culture of a leguminous plant, which derives its nitrogen from the atmosphere, if only the organism producing nodules on the roots is also introduced. It is quite true that the salts in question, if applied to an ordinary arable soil, would furnish an adequate supply of the ash constituents demanded by the plant; but in this case the form in which they would reach the plant would be entirely different from that which occurs in the case of the artificial soil of quartz sand.

In the natural soil, containing calcium carbonate, hydrate silicates, and hydrate ferric oxide, all the alkali salts applied as manure are decomposed; their acids combine with the lime of the soil, and their bases are held in feeble combination on the surface of moist silicates and ferric oxide, from which they are easily extracted by the acid sap of the root hairs. What an immense difference this must make to the plant! In the first place, there is no hurtful excess of saline matter in the soil. The potash has been precipitated upon the surface of the soil particles, while the acid it was formerly combined with has been carried off united with lime in the drainage water. In the next place, the plant is well provided with bases with which the organic acids which it is constantly producing can combine. This is surely a most important point. What can a plant do that is fed on chlorides and sulphates in a mass of pure quartz? How can it get rid of the acids, and obtain bases to supply its own wants? It must be, at least, a very slow and painful business. In a natural fertile soil, not only are the alkalies, as already mentioned, largely supplied to the plant as bases, but the soil water itself always contains a quantity of calcium carbonate dissolved in carbonic acid.

That a plant does require this supply of bases is evident from the character of plant ash. The ashes of plant leaf and stem are always of an alkaline character; those from leguminous plants are highly alkaline, and consist chiefly of carbonates, the residues of the salts of organic acids which have been destroyed on ignition.

The immense improvement in the luxuriance of an artificial culture in sand which is observed when a nitrate is added to the nutritive salts employed, is not to be entirely attributed to the supply of nitrogen thus given. The nitrate is, in this case, the only salt which can supply the plant with a base, and its addition to the soil thus greatly improves the general conditions of growth. The nitrate acts in this way because the nitric acid is employed in the plant for the production of nitrogenous organic matter, and its base at once becomes available for combination with organic acids.

For most experiments there is no necessity for employing the favourite mixture of quartz sand and soluble inorganic salts. Any fertile sandy soil may be used as well, and can be as thoroughly sterilised if sufficient care be taken, but it should not be dried or burnt if its special chemical properties are to be retained. If the nearly complete absence of organic matter is desired, the sand can be taken two feet below the surface.

If an artificial soil is needed, the quartz sand should in every case be mixed with 2–5 per cent. of calcium carbonate. Powdered felspar is an excellent addition to an artificial soil. The mixture must also have a sufficient power of holding water; the sand must, therefore, be fine. If the conditions of the experiment do not forbid it, some humic matter should be supplied. Mr. Mason, who has been very successful with cultures in artificial mixtures, adds 1 per cent. of moss-litter to his soils. The water in natural soils always contains carbonic acid. This point also must not be forgotten, especially when no addition of humic matter has been made. R. WARINGTON.

NOTES.

ON Monday at Osborne the Queen held a private investure of the Orders of the Bath, St. Michael and St. George, and the Star of India. Sir William Roberts-Austen, K.C.B., and Sir William Thiselton-Dyer, K.C.M.G., had the honour of knighthood conferred upon them. Sir Charles Cameron received the decoration of the civil division of the third class of the Order of the Bath.

PROF. MENDELÉEFF has been elected a corresponding member of the Paris Academy of Sciences, in succession to the late Prof. Kékulé.

PROF. E. RAY LANKESTER, F.R.S., has been elected Foreign Associate of the Royal Academy of Sciences, Arts, and Belles Lettres of Belgium, in succession to the late Prof. Leuckart, of Leipzig.

M. DYBOWSKI, director of agriculture in Tunis, and professor at the Agronomic Institute, has been appointed director of the colonial garden about to be established at Vincennes upon the plan of the Royal Gardens at Kew.

M. MILNE-EDWARDS, director of the Paris Natural History Museum, has been promoted to a commandership of the Legion of Honour. Among the new chevaliers of the same order are Prof. Floquet, of Nancy; Dr. Hanriot, member of the Paris Academy of Medicine; Prof. Dufet, of the lycée Saint-Louis; and Prof. Desmons, professor of mathematics at the lycée Janson-de-Sailly.

THE COUNCIL of the Manchester Literary and Philosophical Society have awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium for 1899 to Dr. Charles H. Lees. The Wilde Lecture will be delivered by Prof. W. Ramsay, F.R.S., on February 28, when the presentation of the medal and the premium will also be made.

THE Marquis of Salisbury has forwarded to the Mayor of Dover (Sir W. H. Crundall) a subscription of 100*l.* towards the fund for entertaining the members of the British Association on the occasion of their meeting at Dover this year.

REUTER reports that the Emperor of Russia has granted the Russian Geographical Society the sum of 42,000 roubles towards the fitting out of a scientific expedition to Central Asia.

DR. FLEURENT has been appointed professor of industrial chemistry at the Paris Conservatoire des Arts et métiers, in succession to the late M. Aimè Girard.

THE municipal council of Nuits-Saint-Georges, Department of Côte-d'Or, have decided to erect a monument in honour of M. Tisserand, the distinguished astronomer and late director of the Paris Observatory, and have voted a sum of one thousand francs towards it. M. Tisserand was born at Nuits-Saint-Georges on January 13, 1845, and the erection of a monument in his native town will be an appropriate memorial of his scientific work. A strong patronage committee, having the Minister of Public Instruction and Fine Arts as honorary president, and M. Faye as president, has been formed. The president of the organising committee is Dr. Boursot, Mayor of Nuits-Saint-Georges, and the treasurer is M. Desmazures, the municipal receiver of that town. Admirers of Tisserand's work are invited to send to M. Desmazures subscriptions in aid of the memorial which it is proposed to raise.

DR. H. N. STOKES has been elected president of the Chemical Society of Washington.

THE American Academy of Arts and Sciences has elected Prof. C. D. Walcott, of Washington, an Associate Fellow in succession to the late Prof. James Hall, and Mr. Oliver Heaviside, F.R.S., a Foreign Honorary Member.

WE regret to see the announcement of the death of the Rev. Thomas Hincks, F.R.S., distinguished by his works in several departments of marine zoology.

THE annual general meeting of the Physical Society will take place on Friday, February 10. The Royal Astronomical Society will hold its anniversary meeting on the same day.

THE *British Medical Journal* announces that Prof. William Osler, F.R.S., of the Johns Hopkins University, Baltimore, has accepted an invitation to deliver the Cavendish lecture for 1899, before the West London Medico-Chirurgical Society.

THE Paris correspondent of the *Times* states that the selection, by the Institution of Civil Engineers, of M. Picard, Commissioner-General for the Paris Exhibition of 1900, as an honorary member in succession to the well-known ironmaster, the late M. Schneider, of Creusot, has given great satisfaction in Paris.

REUTER reports that an earthquake, lasting three minutes, occurred in Mexico at nine minutes past five in the afternoon of January 24. The earth-movement was partly from north-east to south-west, and partly from north-west to south-east. More than two hundred buildings were seriously damaged, and ten houses completely collapsed.

SIR WILLIAM MCGREGOR, K.C.M.G., who has been appointed Governor of Lagos, is an M.D. of the University of Aberdeen, and has held various medical appointments in Scotland and the Colonies. In 1888 he was made the first Administrator of British New Guinea, and in 1895 Lieutenant-Governor of the Colony, a post he has held up to the present time. He has received the honorary degrees of LL.D. from Aberdeen, and of D.Sc. from Cambridge.

THE *Lancet* states that the occasion of the delivery, by Sir William MacCormac, of the Hunterian Oration at the Royal College of Surgeons of England this year will be distinguished by the presence of the Prince of Wales, who has also consented, at the president's invitation, to dine with the College the same evening. It is not the first time that the Prince of Wales has honoured the Hunterian orator by attending the delivery of the oration. He was present when Sir James Paget and Mr. Bryant were the orators.

WE have already mentioned the retirement of Prof. Alexander Agassiz from the directorship of the Museum of Comparative Anatomy at Cambridge (Mass.). It appears that Prof. Agassiz's resignation was accompanied by conditions which covered a deed conveying to the President and Fellows of Harvard College munificent gifts of natural history collections. Arrangements have been made by which the late director will have the use of certain rooms and storehouses, as well as a claim on the clerical services of some members of the museum staff. In addition to the collections, there are handed over, as late personal belongings, all the copies remaining in stock of the volumes of the *Bulletin*, and of the *Memoirs*, together with all the publications received in exchange for these issues, about 3500 volumes, and the books which Prof. Agassiz has purchased during the past twenty years, about 5000 volumes. Prof. Agassiz intends now to devote his time to explorations and the publication of reports of these undertakings.

THE twenty-sixth annual dinner of the old students of the Royal School of Mines, with Mr. F. W. Harbord, metallurgical chemist to the Indian Government, in the chair, was held on Friday last, January 27, at the Hôtel Cecil. Of the Professors, Sir W. Roberts-Austen, Rücker, Tilden, and Howes were present, and about 120 of the past and present students. The Chairman, in proposing the chief toast—that of the mining and metallurgical industries—dwelt upon the modern conditions of capital, labour, transport and education, and their bearing on the old students who had to direct those industries. Other speakers were Prof. Roberts-Austen, Prof. H. McLeod, Prof. A. W. Rücker, Sir H. Trueman Wood, Mr. R. C. Styles, Mr. L. C. Stuckey, Mr. Bennett H. Brough, Colonel J. Pennycuick, Mr. Bedford McNeill, and the honorary secretary, Mr. H. G. Graves.

THE British Fire Prevention Committee has just opened its testing station at Regent's Park. The arrangement of the establishment are in the hands of the executive of the Committee, Mr. Edwin O. Sachs (the chairman) personally supervising the work, with the assistance of a sub-Committee, comprising Mr. R. Mond, Mr. Farrow, and Mr. Max Clarke. The purpose of the tests, as defined by Mr. Sachs at Tuesday's press view, is to obtain trustworthy data as to the exact fire-resistance of the various materials, systems of construction, or appliances used in building practice. Such data have not as yet been available, owing to the fact that nearly all investigations of this description have been carried out by individual makers or inventors with specific commercial objects in view. The tests will be of an entirely independent character, arranged on scientific lines, but with full consideration for the practical purpose in view. All reports on tests will solely state the bare facts and occurrences, with tables, diagrams and illustrations, and on no account will reports include expressions of opinion or any expressions that might be read as comparisons or criticisms. The general direction of the tests will be in the hands of the executive, the actual tests being attended by the members of the Council and the members of the Committee in rotation. The principal building of the testing station will be used for laboratory purposes, whilst the gardens are utilised for the principal so-called "full-size" tests. These are generally carried on in brick chambers specially erected for the purpose. The fuel primarily takes the form of gas, and the principal recording instruments are the Roberts-Austen electrical pyrometers with photographic records.

REFERRING to the death of Prof. Gurlt, at Berlin, the *Lancet* remarks that as permanent secretary of the German Surgical Association he had to make the arrangements for the annual meetings of this important society and to publish its proceedings. During the last few years he had the management of the collective investigation on anæsthetics. His name will always be famous as one of the historians of surgery. Scarcely a year before his death he published his great work on the "History of Surgery during the Middle Ages and the Renaissance," the result of more than ten years' study. Prof. Gurlt was the editor of the *Archiv für Klinische Chirugie*, and co-editor of the Virchow-Hirsch *Jahresbeiträge*.

AS already announced, the seventh International Geographical Congress will be held at Berlin from September 28 to October 4 of this year. The proceedings of the congress, which will include all branches of geographical science, will probably fall under three heads. In the first place, there will be lectures on geographical work and travels during recent years. In this section may be expected, among others, reports upon the results of the German Deep-Sea Expedition still at work, and also upon the geographical and geological investigations of Dr. Futterer in Central Asia. Secondly, there will be discussions concerning the international introduction of a common geographical terminology and of international methods, such, for example, as the general adoption of the metric system, of the centigrade thermometer, and of unity in geographical orthography. Lastly, international efforts will be considered, including the greatest geographical problem of the day, namely, the investigation of the Antarctic regions. The German Government has, at the suggestion of the Geographical Society of Berlin, included a sum of 50,000 marks, as a contribution towards the costs of the congress, in the budget estimates already laid before the "Reichstag." It is expected that the congress, which will this year meet for the first time in the fatherland of Humboldt and Carl Ritter, will have an importance corresponding to the high standard of geographical science in Germany.

THE well-known firm of Merck, in Darmstadt, has sent us the first number of a new periodical called *Merck's Digest*, in which they propose to publish a selection of reports on the physiological action and therapeutic uses of remedies, old and new, prepared by the firm. The firm will forward this regularly, and free of charge, to all medical men or chemists applying to Mr. E. Merck, 16, Jewry Street, London, E.C. So many new remedies are being introduced at present, that it is difficult to become acquainted with even those amongst them which are really useful, and this publication is likely to help medical men and others who desire to keep themselves *au courant* with the progress of pharmacology and therapeutics. We learn with deep regret of the death of Mr. William Merck, the senior partner in the firm, who has done such admirable service to pharmacology by providing pure alkaloids for the use of those who have been engaged in experiments on their physiological action.

THE following particulars with regard to the career of the late Mr. Merck are given in the *Chemist and Druggist*:—After his school training, Merck went to Wiesbaden and studied under Remigius Fresenius. Then in 1854 he went to Breslau to continue his chemical training under Loewig at the University of Breslau, but had to return to Darmstadt owing to the death of his father. Affairs having been settled, he next came to London, entering the Royal College of Chemistry as a student of Prof. A. W. Hofmann, with whom his elder brother George had previously been a pupil. It is interesting to recall the fact that Dr. George Merck was one of the first students of the Royal College who undertook original research, his subject (in which he was associated with Robert Galloway) being an "Analysis of the Water of the Thermal Spring of Bath," which was read before the Chemical Society in December 1846, and was the first of the researches published by the Royal College. Wilhelm Merck remained two seasons in London, then went on to Paris to complete his studies under Wurtz. This magnificent training stood him in good stead in after years. Returning to Darmstadt he took his share of the management of the business along with his brothers Karl and George. Mr. Wilhelm Merck took an active interest in the prosperity of his native town, of which he was a councillor for twenty-five years, and to which, as president for a considerable time of the Chamber of Commerce, he rendered important services. Although Mr. Merck was a retiring man, and what he did for Darmstadt was done unostentatiously, the Grand Duke, in 1889, recognised his ability and influence by appointing him Privy Councillor of Commerce, and a life-member of the Upper Chamber of the Grand Duchy. Some time previously he had been decorated with the Grand-Duke Philipp order of the first class.

THE vexed question as the exact meaning of the phrase "one hour after sunset and one hour before sunrise" in the Local Government Act, 1888, referring to the lighting of bicycle lamps, was settled from a legal point of view in a Divisional Court on Thursday last. It had been held that sunset at Greenwich was meant, and the Bristol justices convicted a cyclist for riding a bicycle without a light an hour after sunset thus defined. The alleged offence was committed on August 19, 1898, at 8.15 p.m., which was less than an hour after sunset at Bristol, but more than an hour after sunset at Greenwich. An appeal was made against the decision of the Bristol magistrates; and at Thursday's Court the appeal was allowed, and the conviction quashed, their Lordships holding that the phrase in the Act referred to must not be understood to mean Greenwich time, but local time.

MR. WALTER WELLMAN describes in the *Century Magazine* the journey in the *Frithjof* from Tromsö, Norway, to Cape Tegetthoff, Franz-Josef Land—from which place he writes, under date August 2, 1898. As to his plans he remarks:

"During the sixty days which are to pass before the coming of cold and darkness we hope to drag more than a hundred miles to the northward sufficient food and fuel to carry us through the long winter, with the aid of bear meat, while we hibernate, like bears, in a hole in the ground. In February, before the sun shall have returned, if all goes well, we shall set out upon a five-hundred-mile journey back again to the winter lair, and a two-hundred-mile journey after that to reach the ship which is to come out for us next year [1899]."

IN reporting upon the work at the Marine Biological Station at Port Erin during 1898, Prof. W. A. Herdman, F.R.S., points to the necessity for further exploration in the North Atlantic. Attention has repeatedly been drawn of late years to the importance, both from the purely scientific and the industrial points of view, of the problems involved. The Scandinavians (Petterssen, Ekman, Hjort, and others) have succeeded in unravelling some of the interlacing belts of water from Arctic, Baltic, North Sea, and Atlantic sources which sweep past their coast, and affect the movements of migratory fish. It is only by such work that the mysterious movements of the herring—perhaps the most important food fish on our coast—can be rationally explained. Prof. Herdman states that it was formerly supposed that when the herrings left our shores in autumn they retired to the far north, and next season started from the Arctic regions on their annual migration, led by one large old fish—the "King of the Herrings." It is now believed that breeding and feeding are the two impulses that govern the movements of a fish. The herring comes into shallow water on our coast to spawn, and when it migrates in search of food from the Atlantic to the North Sea, or from our west coast out into deep water, there is reason to believe that it is following those minute organisms which form the plankton carried along in particular currents of water, characterised by the temperature, the salinity, and the microscopic fauna. It is possible by these characters to recognise the currents, to trace their variations from year to year, and so to some extent to determine and predict the movements of the shoals of fish. It follows, then, as Prof. Herdman remarks, that one of the most important things the biologist can do to add to our knowledge of life in the sea is to make a survey of the microscopic floating and drifting life of the sea, and its relation on the one hand to the physical conditions at the time (especially the temperature and salinity of the water), and on the other to the food materials found in the stomachs of the fish.

MR. H. C. RUSSELL has sent us an interesting paper on waterspouts, read before the Royal Society of New South Wales in August last. He states that this phenomenon is frequent on the coast of New South Wales, the spouts often occurring in groups of three or four; but on May 16, 1898, an unusual display occurred at Eden. In the early forenoon, during a light north-west wind, with fine weather and smooth sea, a heavy bank of cloud rose above the eastern horizon, and there was a flickering as if electrical discharges were going on between the cloud and sea, but nothing to indicate what was to follow. During the morning there were fourteen clear and distinct waterspouts, reaching from clouds to sea. The process of formation was—a rotary motion of the waves, large quantities of broken water being raised up gradually as a white misty-topped column, the misty part preceding the denser part by 100 to 150 feet. This went on for three or four minutes, during which time the clouds had formed an inverted cone, which seemed to be alternately dipping down and receding, with an interval of about thirty seconds between the dips, until the two cones met, and all the misty matter was absorbed. The column then remained unchanged for some minutes, the overhanging cloud getting denser, and moving slowly until the spout got out of the perpendicular and divided in the middle, the top part rising, while the lower half sank to the ocean. The paper is accompanied by nine plates, showing specimens of waterspouts observed at various times.

THE index number of *The Physical Review* (vol. vii.) contains an account of the determination of the electro-chemical equivalent of silver, recently undertaken by Messrs. Patterson and Guthe, together with a description of the experiments of Messrs. Eddy, Morley, and Miller on the velocity of light in the magnetic field, and a paper by Mr. Ferry on a photometric study of the spectra of mixtures of gases at low pressures. The first article calls attention to the recent work of Kahle, who for a number of years has been engaged at the Imperial Institute at Berlin using Helmholtz's current-balance for investigations on electro-chemical equivalents. Kahle discriminates between "old" and "new" solutions; thus an "old" solution of argentic nitrate is one originally neutral, which has become acid by successive use in voltameters. For a given quantity of electricity, larger deposits are obtained with this than with "fresh" solution; the difference often exceeds one part in one thousand—this must be regarded as a very important observation. Kahle's work is referred to in *Zschr. f. Instrum.*, 17, 144, 1897, and 18, 141, 1898; also August and September 1898. The authors describe their own experiments in which the *e.c.e.* is measured independently of g and H, by balancing the moment due to the electro-dynamic action of the two coils of an absolute electro-dynamometer, against the torsional moment of a wire with very small elastic fatigue.

FOR a long time past the City of Manchester has been in difficulty as to the disposal of its sewage, and at the present time an order obtained by the Mersey and Irwell Board for stopping the pollution of the Ship Canal by the effluent from the existing tanks, carrying a penalty of 50*l.* a day, is only in abeyance pending the result of the works now proposed to be carried out. A scheme for the construction of a culvert to carry the sewage to the estuary of the Mersey, at a cost of 258,000*l.*, was rejected by the ratepayers. It is now proposed to treat the sewage on the septic principle, which has been found successful at Exeter and other places, and to enlist the services of bacteria for the purpose of the sewage disposal; or, as the plan was described at the inquiry of the Local Government Board, recently held, "as the domestication of bacteria for the purposes of sewage disposal." The mineral matter arising from mud detritus is first to be separated by the sewage passing through catch-pits, and it is then to pass over coke-filters, which will cover fifty acres, and in these the "tame microbes" are to be turned on to resolve the impure sewage into water of sufficient purity to be discharged into the Ship Canal. The quantity of sewage to be dealt with is 20,000,000 gallons a day, and this is now treated with chemicals at an annual cost of 17,000*l.* a year, at least half of which is to be saved by the action of the microbes, and it is anticipated that an effluent will be produced that will be satisfactory to the Mersey and Irwell Committee. The Manchester sewage is of an exceptional character, as it contains much trade refuse; but experiments, which have for some time past been conducted by Prof. Frankland, have proved that by means of "double contact beds" the bacteria soon get accustomed to take this sewage, and it has been shown that by this means the whole sewage of the city can be successfully dealt with.

THE international quarterly journal hitherto published under the title *Terrestrial Magnetism* will in future bear the name *Terrestrial Magnetism and Atmospheric Electricity*. With the forthcoming (March) number this periodical, which is devoted exclusively to terrestrial magnetism, and atmospheric electricity—such as earth currents, auroras, &c.—will enter on its fourth

volume. The journal is conducted and published by Dr. L. A. Bauer and Mr. Thomas French, jun., with the assistance of a number of distinguished physicists in various parts of the world. Every issue of the periodical hereafter is to contain at least eight pages of abstracts and reviews, and in every number a half-tone portrait of an eminent magnetician will appear.

A NUMBER of valuable physical papers have been recently published in English in the *Communications* from the Physical Laboratory of the University of Leiden. In the parts now before us, Dr. H. Kamerlingh Onnes describes a hydrogen thermometer for the measurement of low temperatures, and a standard open-tube manometer for high pressures, consisting of sixteen partial manometers connected together in series. Mr. Ch. M. A. Hartman gives the results of observations on the composition and volume of the coexisting vapour and liquid phases of mixtures of methyl-chloride and carbonic acid, and arrives at the result that at the chosen temperature of 9·5° the vapour pressure of the liquid phase of the mixture may be expressed in terms of those of its components, with near approximation, by the formula $p = p_1(1-x) + p_2x$. In another part, Dr. E. van Everdingen, jun., discusses the galvano-magnetic and thermo-magnetic phenomena in bismuth, and criticises Riecke's theory.

PROF. E. VILLARI writes in the *Atti dei Lincei*, vii. 10, on the way in which tubes diminish the electro-dispersive power of Röntgen rays. The experiments all point to the conclusion that the discharge of an electroscope by the action of these rays is due to the air acted on by them. An electroscope placed in the umbra of the rays is discharged by the Röntgenised air which passes into the umbra by diffusion. If between the Crookes' tube and the electroscope there be interposed a tube of glass or zinc, which cuts off the lateral divergent rays, the discharge is greatly retarded, and the same is the case when the ball of the electroscope is enclosed in a tube turned towards the source of the rays, as this prevents the lateral air from reaching the electroscope. When the electroscope is covered by a tube of zinc, so that charges of opposite signs are developed by electrostatic induction on the inside and outside of the tube, the action of Röntgen rays is in the first place to discharge the outside of the tube, and the electroscope falls several degrees; subsequently the electroscope itself is slowly discharged by the Röntgenised air inside the tube. An exactly analogous effect takes place with a tube of paraffin. Under the action of Röntgen rays, or of a flame, the tube becomes oppositely charged to the electroscope, and the latter is afterwards slowly discharged by the Röntgenised air inside the tube. If there be no air between the tube and the electroscope, the initial discharge alone takes place. The present experiments thus afford an explanation of the phenomena observed with tubes and blocks of paraffin, which were described by Lord Kelvin, but left uninterpreted, some time since, in the columns of NATURE.

WE have received a copy of the "Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the year 1896," by F. B. Weeks, published as *Bulletin* No. 149, of the United States Geological Survey. This contains reference to 788 papers, books, maps, &c., with a most excellent classified index. It records works on the geology of the United States, Canada and Mexico, whether published in North America or elsewhere.

THE Cretaceous Foraminifera of New Jersey are described by Mr. R. M. Bagg, jun., in *Bulletin* No. 88 of the United States Geological Survey, 1898. Some of the prominent species, including also several new forms, are illustrated in six plates. The Foraminifera were collected from the Greensand series of the Upper Cretaceous, and Mr. Bagg remarks that he has frequently found the tiny shells filled with glauconite: in other cases the grains of glauconite are internal casts of Cristellariæ, &c. Many of these forms are partially filled with a light brown clay, suggesting the early stage in the formation of the glauconite grain. Mr. Bagg pays a deserved compliment to Mr. C. D. Sherborn, whose "Bibliography of Foraminifera," and "Index to the Genera and Species of Foraminifera," have, by their completeness and accuracy, lightened the labours of all workers on the subject.

WE have received a copy of the second edition of Mr. F. N. Williams's "Provisional and Tentative List of the Orders and Families of British Flowering Plants."

PROF. R. V. WETTSTEIN reprints, from the *Transactions* of the German Association for Natural Science and Medicine of Bohemia, an interesting paper on the various modes of protection of the flowers of geophilous plants—that is, those whose flowers are more or less completely formed beneath the surface of the soil, a class which includes all our very early spring-flowering herbaceous plants.

MR. T. F. MOTT sends us two papers on the origin of organic colour, in which he thus sums up his conclusions:—That the gradual development of organic colour is a physiological necessity; that brilliant coloration is a mark of the maturity of some organic force-wave, in which the molecular rhythm has reached its maximum simplification; and that the effect of insect selection in the development of coloured flowers is comparatively small.

IN a paper in the number of the *Biologisches Centralblatt* for January 1, 1899, Prof. J. Wiesner reviews the state of our knowledge respecting the adaptation of leaves to the intensity of light. He classifies leaves under two heads in this respect—"photometric," or those which assume special positions in order to receive as much light as possible, or to avoid too strong a light; and "aphotometric," those which have no such faculty. The former, again, may be either "euphotometric," when they place themselves in a position to receive the maximum of diffused light; or "panphotometric," when they are adapted to receive both direct and diffused sunlight, but are protected against an excess of the former.

MESSRS. DULAU AND CO. have issued a catalogue of books and papers on general geology which they have for sale.

WITH reference to the appeal for additional work on telegony, referred to last week (p. 301), Mr. G. B. Bulman asks us to say that communications should be addressed to him at Cullercoats, Whitley, R.S.O., Northumberland.

AN illustrated catalogue of physical apparatus, including drawing, surveying, and engineering instruments, balances and weights, and apparatus required in classes under the Department of Science and Art, has been received from Mr. T. M. F. Tamblyn-Watts.

THE following lectures have been arranged to take place at the Royal Victoria Hall, Waterloo Bridge Road, on Tuesdays during February:—February 7, "About some Worms," Prof. Weldon, F.R.S.; February 14, "Some Facts about Liquids," Prof. Holland Crompton; February 21, "India," Mr. R. M. Beachcroft; February 28, "Volcanoes," Prof. H. G. Seeley, F.R.S.

THE osteometric index calculator, referred to by Mr. David Waterston in NATURE of October 20, 1898 (vol. lviii. p. 597), is described and illustrated in the *Journal of Anatomy and Physiology*. The instrument provides a ready means of finding

the cephalic index from two measures of length and breadth of the head.

MESSRS. GINN AND CO. announce the forthcoming publication of "A Laboratory Manual in Astronomy," by Mary E. Byrd. The manual is designed as a handbook of laboratory instruction to accompany the study of elementary and general astronomy in secondary schools and colleges. The same firm announces a college text-book of "Physics," by Profs. Charles S. Hastings and Frederick E. Beach.

THE zoological material collected by Dr. Arthur Willey from New Britain, New Guinea, Loyalty Islands, and elsewhere, during his expedition in search of the eggs of the Pearly Nautilus, is being studied by a number of distinguished zoologists, and the first two parts of a work containing the results have been published by the Cambridge University Press. It is expected that five or six similar parts will be issued; and we defer our notice of the work until all of them have been published.

THE density of liquid air is the subject of an interesting paper by Prof. A. Ladenburg and Dr. C. Krügel, in the current number of the *Berichte*. The hydrostatic method with a Westphal balance was employed. It is pointed out that a determination of the density of liquid air obtained in the usual way is of little value unless accompanied by a determination of the exact composition of the mixture, since, as is well known, after standing some time, the residual fluid is nearly pure oxygen. In these experiments, the whole of the liquid was allowed to evaporate into large gasholders, and the gaseous mixture analysed. From these results, the authors calculated that the density of normal liquid air containing 20·9 per cent. of oxygen would be ·871. It was found that the density of the liquid containing 93·6 per cent. of oxygen was higher than that of pure oxygen. It is suggested that this may be due to carbon dioxide or krypton.

CONSIDERING its exceptional behaviour with respect to hydrogen, the metal palladium has not hitherto been used to the extent that would have been expected as a reducing agent in organic chemistry. The mode of application of palladium, however, described by Dr. N. Zelinsky in the current number of the *Berichte*, would appear to promise a more extensive use of this metal. A zinc-palladium couple is prepared from zinc and palladium chloride, in a manner similar to the well-known zinc-copper couple. This is placed in alcohol, and acid added until hydrogen gas just commences to be evolved. At this stage the palladium black is saturated with hydrogen, and produces energetic reduction of the alkyl iodide or bromide, the acid and iodide being now added alternately. Hexamethylene, and the ethyl and methyl-hexamethylenes, which are obtained with great difficulty from their halogen derivatives by ordinary reducing agents, are produced in yields of 70–75 per cent. of the theoretical, when the corresponding iodides or bromides are treated in this way.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by Miss K. M. Burne; a Green Monkey (*Cercopithecus callitrichus*, ♂) from West Africa, presented by Mr. F. W. Coker; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Miss A. M. Deeks; a Black-headed Lemur (*Lemur brunneus*, ♂) from Madagascar, deposited; a Tui Parrakeet (*Brotogerys tui*) from Brazil, an Uvæan Parrakeet (*Nymphicus uvaensis*) from the Island of Uvea, Loyalty Group, three Common Crowned Pigeons (*Goura coronata*) from New Guinea, purchased; two Barnard's Parrakeets (*Platycercus barnardi*) from South Australia, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

February 10. 19h. Venus at greatest elongation 46° 46′ west. This planet rises nearly three hours before the sun, and presents a brilliant appearance in the south-east sky.
10. Date of computed perihelion passage of Denning's comet (1881 V.).
11. 10h. 39m. Minimum of Algol (β Persei).
12. 7h. 35m. to 8h. 28m. Occultation of the star 19 Piscium (mag. 5·2) by the moon.
14. Mars. Illuminated portion of disc 0·969.
14. Venus. ,, ,, ,, 0·517.
14. 7h. 28m. Minimum of Algol (β Persei).
15. Jupiter. Polar diameter 35″·8. The planet rises at midnight, and is favourably visible afterwards.
16. 15h. 45m. to 17h. Transit of Jupiter's Sat. III.
18. 8h. 53m. to 10h. 11m. Occultation of the star 103 Tauri (mag. 5·5) by the moon.
24. Saturn. Outer minor axis of the outer ring = 16″·82. Polar diameter 15″. The planet may be well seen as a morning star.

HARVARD COLLEGE OBSERVATORY. — In the fifty-third annual report of this well-known observatory, Prof. Pickering, the director, again chronicles the completion of an enormous amount of work. With the east equatorial (15-inch), under the charge of Mr. O. C. Wendell, about 25,000 photometric light comparisons have been made, chiefly with the new polarising photometer with achromatic prisms. This instrument was also used in the photometric measurement of Jupiter's satellites while undergoing eclipse.

Similar photometric comparisons of variable stars, to the number of about 1650, have been made with the west equatorial (6-inch). These observations are now reduced and will shortly be published. In addition, comparison stars have been selected for sixty other variables, and the co-operation of other astronomers in following up the stars when too faint for the 15-inch is invited, for which purpose charts and lists of the stars in question will be furnished on application.

The reduction of the observations of fundamental stars with the meridian circle, by the late Prof. Rogers, were incomplete at the time of his death, and are still therefore under discussion.

With the meridian photometer the observations have been made by the director. Extending over 152 nights, the number of settings has been 73,684. This completes the work that was planned in 1892 for this instrument, and it is proposed to send it to Arequipa next spring, to revise the contents of the Southern Harvard Photometry.

Photometric observations of faint stars have also been commenced by the director using a 12-inch telescope mounted horizontally, and having a Welsbach burner for artificial comparison.

In connection with the spectroscopic work of the Henry Draper Memorial, 2192 photographs have been taken with the 8-inch telescopes. By the examination of these and other plates taken with the Bruce and Bache telescopes, Mrs. Fleming has detected twelve new variable stars, six of which showed *bright* hydrogen lines; nine stars have spectra of the fourth type, seventeen of the fifth, and ten objects are catalogued as gaseous nebulæ. In three known variables—V Tauri, U Cancri, T Capricorni—the hydrogen lines have been found bright.

With the 11-inch Draper telescope 873 plates have been taken, and a photograph of α Canis Majoris obtained at mid-day under conditions rendering it probable that bright stars could be thus usefully photographed when in transit.

Photographs of stars near the pole have been taken with the 15-inch reflector, with the object of accurately determining the constants of aberration, precession, and nutation.

The examination of the photographs of star clusters for variables has been continued, resulting in the detecting of 509 stars of this type. The most notable occur in the clusters ω Centauri, Messier 3, Messier 5, and Messier 15.

With the Bruce photographic doublet, photographs have been obtained which, with three and four hours' exposure, show no distortion of the star images, and Prof. Turner reports favourably on the freedom from distortion over an area of 4° × 4°. Both chart plates and stellar spectra have been taken with this instrument.

HARVARD ASTROPHYSICAL CONFERENCE.—Several items in the report of this conference have already been noticed, but in the pamphlet now distributed by Prof. M. B. Snyder, of the Philadelphia Observatory, there are some points of interest.

Mrs. Fleming presented a paper on stars of the Vth type in the Magellanic clouds. These stars have spectra consisting chiefly of bright lines, and are usually known as Wolf-Rayet stars. Up to 1897 the number of these objects known was 67, and all lie closely along the central line of the Milky Way. Photographs taken at Arequipa with the Bruce telescope revealed 21 of these objects in the large Magellanic cloud, 3 others in the Milky Way, and 1 in the small Magellanic cloud, bringing the total number up to 92. Of these fifth-type stars 22 are thus in the Magellanic clouds, and this large proportion renders probable the connection of these objects with the Milky Way.

Mr. E. S. King described an ingenious method of converting prismatic spectra into normal spectra. To do this the original plate is inclined to the plate on which the copy is to be made, by an amount calculated to make the scale exact for three points in its length, while at the same time maintaining good focus. As illustrations he showed several stellar spectra compared with Rowland's map of the solar spectrum. Prof. Pickering said that the method was perfectly general, and all scales were thus reproducible.

Mrs. Fleming, in a paper on classification of spectra of variables of long period, describes the characteristics of these objects. About 100 stars of this class are known, and all have the hydogen lines bright. Examination of the relative intensities of these lines has led to the class being divided into eleven groups, of which two are mentioned in detail. One group, represented by R Lyncis, has a spectrum resembling α Tauri, but having Hβ and Hγ strongly bright, while Hδ is barely visible. Another group, typified by R Leonis, shows a continuous spectrum with Hβ invisible, Hγ barely visible, and Hδ strongly marked.

Prof. G E. Hale presented a review of work on the spectra of stars of Secchi's fourth type. These are the blood-red stars, and the spectra of twenty-two of them have been obtained with the spectrograph of the 40-inch Yerkes telescope, mostly with a dispersion of one prism. For the two brightest stars of this class, 132 and 152 Schjellerup, three prisms were employed. The photographs show a large number of lines hitherto unrecorded, most of which are dark; but it is stated that there seem to be a number of bright lines.

The presence of bright lines in 152 Schjellerup was, it is stated, confirmed by Profs. Keeler and Campbell at the Lick Observatory. The wave-lengths of two of the brightest of these lines agree very closely with those of the two brightest lines in the Wolf-Rayet stars, as measured by Campbell; but no connection between these two classes of bodies is yet indicated. A reproduction of the photographed spectrum of 152 Schj. is published in the *Ast. Phys. Journ.*, November 1898.

THE PLAN OF THE EARTH AND ITS CAUSES.[1]

IN a passage in the "Novum Organum" Bacon pointed out resemblances between the continents of the Old and New Worlds, which he thought showed that their shapes were not due to chance, but to the action of a common cause. Similar coincidences have been repeatedly noticed by geographers, who have accordingly been led to the belief that the distribution of land and water on the globe is based on a definite plan. Any such plan can only be recognised in broad outline, since geographical shapes depend on an intricate series of local accidents. Topographical form depends on such inconstant, incalculable factors that the stages of its growth are often untraceable. The missing links of geographical evolution are as numerous as those of organic evolution. Nevertheless, belief in the existence of a fundamental geographical plan is as old as geography. It was expressed in some of the earliest classical maps; it possessed the minds of mediæval cartographers, and led to their fantastic wheel maps; and it was popularised in the first half of the present century by the teaching of Humboldt and Élie de Beaumont. But with the growth of Lyellism and its doctrine of the interchange of land and sea under the influence of local variations in level, the idea fell into discredit.

[1] Abstract of lecture to the Royal Geographical Society on January 23, by Dr. J. W. Gregory.

But the discoveries of oceanography and geology have shown what allowances should be made for the obscuring action of minor oscillations, and thus have revealed fresh geographical homologies and explained apparent exceptions. The introduction of such local changes is, however, unnecessary, since the existence of a geographical plan of the earth is shown by three features: (1) the concentration of land in the northern, and of water in the southern hemisphere; (2) the triangular form of the geographical units, and the southward tapering of the land masses. From these two features it follows that there is a "northern land belt" from which three continents project southward, separated by three oceans, which expand until they form a "southern ocean belt." The third feature is the antipodal position of oceans and continents. The main problem of geomorphogeny is the explanation of these three facts.

The question is simplified by remembering that the earth consists of three parts: (1) the unknown internal centrosphere; (2) the rocky crust, or lithosphere; (3) the oceanic layer, or hydrosphere. Oceans and continents occupy, respectively, depressions and elevations of the lithosphere; and their distribution, therefore, directly depends on the distribution of the irregularities in its surface. If the existing irregularities have remained unchanged throughout geological time, then the problem is astronomical rather than geographical and geological.

The attempts to solve the problem on the basis of the permanence of the main geographical features may be grouped into four sets: (1) Prof. G. H. Darwin has attributed the main geographical lines to tidal wrinkles in the viscous crust; (2) Prinz has assigned them to torsion due to the acceleration of the equatorial and southern belts of the earth, and retardation of the northern land belt; (3) Sir J. Lubbock and Prof. Lapworth have independently explained continental form as due to the intercrossing of two sets of folds, one parallel to the equator and one at right angles to it; (4) Lord Kelvin refers back the main geographical divisions to an even earlier period than the previous theories; for he regards them as due to shoaling in the last molten layer of the globe, over areas determined by previous chemical segregations in the nebula. These theories are not necessarily inconsistent with the asymmetry between the northern and southern hemispheres; the primitive wrinkles, the double folds, and the nebulous segregations are each in harmony with a considerable amount of geological evidence; but the theories are geographically inadequate, because they do not explain how the existing asymmetry has been developed. To do this, some more continuously acting cause is required, such as the secular contraction of the earth, on which Élie de Beaumont based his famous theory. His system, however, regarded the world as symmetrical, and was too rigidly geometrical to apply satisfactorily to a heterogeneous globe. In his "pentagonal réseau" antipodal areas were similar; for he regarded the world as a spheroid based on a pentagonal dodecahedron, which is a holodedral form; whereas, owing to the dissimilarity of antipodes on the earth, the lithosphere may be better regarded as hemihedral. The recognition of this fact led to the great advance on Élie de Beaumont's theory made by Lowthian Green, which has been advocated by de Lapparent and Michel-Lévy.

The tetrahedral theory does not regard the world as a regular tetrahedron; but suggests that, owing to the collapse of the earth's crust due to contraction, the lithosphere has undergone a tetrahedroid deformation. That collapsing shells tend to become tetrahedral, just as short tubes often collapse trigonally, is shown by experiments. "Nothing," says E. D. Preston, "is more in accordance with the action of physical laws than that the earth is contracting in approximately a tetrahedral form. . . . Experiments on iron tubes, on gas bubbles rising in water, and on rubber balloons, all tend to bear out the assumption that a homogeneous sphere tends to contract into a tetrahedron."

If such be the case, then the lithosphere would be depressed on four faces, which, being lower, would be naturally occupied by oceans; while the four projecting coigns would stand up as continents. In such a tetrahedrally deformed earth there would be a central ocean (the Arctic) on one face surrounded by a land belt, from which three meridional continents would run southward; they would each taper to a point, below which would be a southern ocean belt, from which three oceans would project northward. South of the ocean belt would be an Antarctic continent.

The arrangement of land and water on such an ideal, de-

formed globe would be identical with that on the earth; for there would be a northern concentration of land, and a southern excess of water; the geographical shapes—except in the case of the two polar units—would be triangular, and land and water would be antipodal.

The agreement between the facts of geography and the requirements of the tetrahedral theory goes further. The main watersheds and mountain systems—which are by no means coincident—have both a tetrahedral plan, forming a girdle in the northern hemisphere and three approximately equidistant meridional lines in the southern hemisphere.

The first obvious objection to the hypothesis of tetrahedroid deformation of the lithosphere is that physicists having proved the rigidity of the earth, any such deformation is impossible. But the arguments in favour of the earth's rigidity apply to the globe as a whole, and do not debar limited deformation of the crust. Such elasticity is now regarded as demonstrated by the movements of the pole, under such trivial influences as the unequal melting of the polar ice or unbalanced falls of snow. The second objection is that the earth is known to be an oblate spheroid, and therefore is not tetrahedrally deformed. But, owing to the equatorial flattening of the world, it is not a spheroid of revolution; owing to the differences of shape between the northern and southern hemispheres, it is not even an ellipsoid. Herschel pithily stated the facts in his remark that "the earth is earth-shaped"; and Listing's term "geoid" is now generally adopted for the figure of the earth. The geoid is, however, by no means a regular figure; the differences between the astronomical and trigonometrical determinations of positions show that the form is subject to numerous deviations, which cannot at present be attributed to any definite system; for accurate observations have not been made over a sufficiently large portion of the earth. But there are suggestions that, like the physical features of the earth, the major geodetic variations may be on a tetrahedral plan; for there is evidence of great deficiency of gravity in two areas (East Russia and Central U.S.A.), which may represent two of the three minima which should occur in the northern land belt. The ordinary explanation of these deficiencies in gravity—viz. that they are due to vast subterranean blocks of light material—is improbable; because in the Russian case the existence of such blocks is disproved by observations on deviations of the plumb-line (Helmert); and in the American case, Mildenhall has shown that no reasonable, or even possible, assumption will explain the facts. The agreement of gravity observations with Bessel's ellipsoid in Central Europe, and their approximation to Clarke's ellipsoid in Eastern Russia (as shown by Helmert), may indicate that both ellipsoids accurately represent the curvatures of the two areas on which they were mainly based, and that they merge into one another along the line of the East African meridional edge.

Geological evidence gives important support to the tetrahedral hypothesis, for the northern land belt appears founded on three great "schild" (Suess) or "coigns" of Archean blocks; these Scandinavian, Canadian, and Manchurian coigns are 120° apart. The significance of the angular distance between them was first pointed out by De Lapparent in the case of the first two. South of the coigns lines of elevation on the meridional edges would be expected; and, though the geological structure of the country along the three lines differs fundamentally, the three lines of recent or still continuing earth-movements of the Andes, Erythrean rift-valley, and East Australian coast occur in the right positions. That tetrahedral geological symmetry is not only an incident of the present, is shown by the distribution of land and water, and by the arrangement of the mountain system at the end of the Palæozoic; for both were on a tetrahedral symmetry. But in that period the present arrangement was reversed, the land belt being southern and the ocean belt northern in position; the position of the meridional land lines was the same as at present.

Such a change in the areas of tetrahedral flattening would be impossible in a stationary world; but in a revolving globe the collapse, due to contraction, is steadily resisted and confined within narrow limits by the effects of the rotation, which tends to restore the world to the more stable spheroidal form. The great mountain building periods of the earth's history may be due to instability resulting from periods of slow deformation; and the periods of great marine transgressions (*e.g.* the repeated Mesozoic transgressions after the mountain elevations at the close of the Palæozoic) are easily explained as due to the restoration of more regular spheroidal form.

Hence the distribution of land and water on the globe may be regarded as the resultant of two opposing forces, collapse due to secular contraction causing deformations, and the tendency due to the earth's rotation towards the recovery of the spheroidal form. The plan of the earth may be attributed to the continuous foundering of the lithosphere in consequence of the unceasing shrinkage of the centrosphere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Among the lectures announced for this Term may be noted:—Prof. Burdon-Sanderson on general pathology, Dr. Ritchie on special pathology, Prof. Thomson on cranial nerves and digestive system, Prof. Esson on synthetic geometry of conics and cubics, Prof. Turner on mathematical astronomy, Prof. Miers on physical properties of crystals, Mr. Bowman on microscopical examination of crystals, Prof. Elliott on elliptic functions, Prof. Clifton on electricity, Mr. Walker on physical optics, Mr. Goodrich on aves and mammalia, Mr. Bourne on Ctenophora, Prof. Odling on the sugars, Mr. Watts on organic chemistry, Mr. Veley on physical chemistry, Mr. Marsh on stereo chemistry, Prof. Gotch on physiology of the excitable tissues, Mr. Burch on physiological physics, Prof. Sollas on evolution of the earth and on palæontology, Prof. Tylor on development of culture, Mr. Barclay-Thompson on sauropsidan morphology and palæontology. The other lectures announced are more particularly devoted to the general subjects required for the schools.

Elections will be made in the course of the present term to the Sedleian Professorship of Natural Philosophy, vacant by the death of Prof. Bartholomew Price, and to the Linacre Professorship of Comparative Anatomy, vacant by the resignation of Prof. Ray Lankester.

CAMBRIDGE.—The Duke of Devonshire, Chancellor of Cambridge University, presided on Tuesday over a meeting at Devonshire House to consider the financial needs of the University and the establishment of a Cambridge University Association. A full report of the meeting appeared in yesterday's *Times*. The Chairman set forth the various requirements of the University, in buildings and endowments, to meet the increased demands of the day, and said that altogether something like half a million was needed. He announced that he would contribute 10,000*l.* to the endowment fund. A contribution of 10,000*l.* was promised from Lord Rothchild's firm, and the Drapers' Company intimated their intention of contributing 800*l.* a year for ten years in support of a Professorship of Agriculture. It was resolved to form a Cambridge University Association for the purpose of enlarging the resources of the University.

THE following gifts to educational institutions in the United States are announced in *Science*:—The late Henry Clark Warren, of Boston, an accomplished Oriental scholar, has left to Harvard University a large sum principally for the Sanscrit department, but including 10,000 dollars for the Peabody Museum of American archæology and ethnology, and 10,000 dollars for the Dental School. The same University receives 5000 dollars by the will of the late Susan B. Lyman, Dedham, Mass., and 10,000 dollars by the will of the late Mrs. Mary Ann P. Weld, of Boston, the latter sum being for the purpose of founding a Christopher Minot Weld Scholarship. The Teachers' College of Columbia University has received an anonymous gift of 10,000 dollars.

THE Technical Education Board of the London County Council have arranged to award four scholarships of the value of 150*l.* each, tenable from Easter to Christmas 1899, in some higher commercial school or schools on the continent. Candidates must have had experience in teaching commercial subjects, and must possess a good conversational knowledge of the language of the country in which they proposed to hold these scholarships. The Board's object is to afford to teachers who were well acquainted with some branch or branches of commercial education an opportunity of making themselves acquainted with the organisation and methods of the more successful commercial high schools of the continent. Sir Philip

Magnus has succeeded in arranging for the admission of the Board's scholars to the two principal higher schools of commerce in Paris and to the similar schools in the three Italian towns, Bari, Genoa, and Venice, his suggestions having been most kindly received by M. Bocquet at Paris, and by Signor Fortis, Minister of Industry and Commerce at Rome.

MR. BALFOUR has written a long letter to a constituent in East Manchester on the subject of University education in Ireland. After giving reasons why, in his judgment, the expedient of leaving the one existing teaching University in Ireland—Trinity College—to meet, by a natural process of expansion, the growing educational needs of the country would not be successful, Mr. Balfour suggests that the plan which seems best to solve the University problem, both for the Presbyterians and other Protestants in the north and for Irish Roman Catholics generally, is to establish by a single Act two new teaching Universities—one in Dublin and one in Belfast—on precisely similar lines, and differing in no particular excepting the names of the gentlemen first appointed to serve on their respective governing bodies. As the University in Belfast would absorb the existing Queen's College, the governing body of the new institution should be so constituted as to be a continuation of the old. As the Dublin University is designed to attract those Roman Catholics who now hold aloof from University life altogether, its governing body as first constituted should no doubt, in the main, be of their own way of thinking. A University so constituted would, in Mr Balfour's opinion, meet the need of Roman Catholics, but it would not be a Roman Catholic University, except in the sense that Trinity College and the new University in Belfast would be Protestant, and in that case there would be in Ireland two Protestant Universities to one Roman Catholic.

THE executive council of the County Councils Association passed the following resolutions at a meeting held on January 25: (1) The administrative county (in which term is included the county borough) is *prima facie* to be accepted as the area for secondary education. Nevertheless, provision should be made enabling the council of any county or of any municipal borough to make a representation to the central authority to the effect that it would be desirable, in the best interests of education, that an educational area other than that of the administrative county should be constituted; and if the central authority, after a local inquiry at which all parties interested may be heard, are of opinion that it will be to the best interests of education that such an area should be constituted, they may make an order accordingly. The central authority should be empowered by such order to make such financial adjustments as they may deem equitable and advisable. (2) That the proposal of the Association of School Boards be not approved, and that the executive council, while thinking it desirable that the new local authorities for secondary education in administrative counties should include members of the governing bodies of elementary schools (both board schools and voluntary schools), consider that this will be better secured by a power of co-optation exercised as is recommended in paragraph 36 of the report of the Royal Commission on Secondary Education than by giving any right of separate representation on the new authorities to school boards, which represent parts only of the administrative county.

PROF. S. W. WILLISTON describes in *Science* a remarkable condition of things which exists in Kansas as to the text-books used in the State schools. He says that at the last biennial session of the Legislature of Kansas there was passed what is known as the State uniform text-book law. A commission was appointed whose duty it was to select the text-books of all grades used in the public schools of the State, which were to be furnished at a stipulated price to all pupils. No other text-book than the one selected may be used by any school under pain of severe penalties. The law has now been in force for two years, and these books are being used by several hundred thousand pupils. It appears, however, that specialists or experts are not consulted in the choice of the text-books. Wide latitude was given to the commission, the one important stipulation being that the books should be cheap; and the result is that science manuals are used full of unsound and incorrect statements. The principle of specifying text-books might be a good one if the board which examined the books were wise and representative, and contained a fair proportion of practical teachers; but in Kansas this does not appear to be the case. The School Board of London has a book committee which draws up a list of approved text-books, and a glance at the list is sufficient to show that we need not go to the States for instances of books selected more for cheapness than scientific quality.

SCIENTIFIC SERIALS.

American Journal of Science, January.—The thermodynamic relations of hydrated glass, by C. Barus. During the first or opaque stage of the reaction of hot water on glass at 200° C., volume contraction and increase of compressibility are both marked phenomena. During the second stage the water-glass becomes more and more clear and limpid. Capillary tubes on cooling become rods of brittle water-glass. They always break eventually along their length.—Platinum and iridium in meteoric iron, by J. M. Davison. From 608·6 gr. of Coahuila meteoric iron, 0·014 gr. of metallic platinum were obtained, and 0·0015 gr. of a black powder, which is probably ammonium iridi-chloride. No diamonds were discovered.—Studies in the Cyperaceæ, viii., by T. Holm. This article deals with the root, the rhizome, the aerial stem, and the leaf of some North American species of *Scleria*.—Regnault's calorie, and our knowledge of the specific volumes of steam, by G. P. Starkweather. The writer adduces evidence from Regnault's own experiments to show that his conclusion as to the constancy of the specific heat of water between 0° and 30° is correct. He maintains that all our knowledge concerning the density of steam is limited to the saturation line, the experiments on superheated steam presenting discrepancies which cannot be reconciled.—The estimation of boric acid, by F. A. Gooch and L. C. Jones. The salts are treated with sulphuric acid, and the boric acid is distilled with methyl alcohol, and the distillate evaporated over calcium oxide. In searching for a less hygroscopic material to replace the calcium oxide as a retainer for boric acid, the authors found that sodium tungstate, fused with a slight excess of tungstic acid over that contained in the normal tungstate, answers the purpose excellently.—New Actinians, by A. E. Verrill. Describes a number of new families and genera from Hong Kong, Guadeloupe, Panama, Peru, and San Salvador.—What is the Loess? by F. W. Sardeson. The Loess loam, in combination with land and fresh-water shells, forms a very strong argument in favour of the purely æolian origin of the Loess.—Absorption of gases in a high vacuum, by C. C. Hutchins. The vacuum of Röntgen ray tubes is increased by successive discharges, until it becomes too high for any discharge to pass. This can be prevented by putting some mercuric oxide in a side tube surrounded by a platinum wire heated by a shunt. If a suitable spark gap is inserted in the shunt, the heating may be made automatic. The oxide gives off oxygen when heated, which lowers the vacuum to a proper amount.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, January 27.—Mr. G. Griffith, Vice-President, in the chair.—A mathematical paper was read by Dr. E. H. Barton on the equivalent resistance and inductance of a wire to an oscillatory discharge. Maxwell's treatment of the self-induction of cylindrical conductors was extended by Lord Rayleigh, in an article published in the *Phil. Mag.* for May 1886, to alternate currents that follow the harmonic law at constant amplitude. Dr. Barton now modifies the analysis, and further extends it to include the decaying periodic currents obtained in discharging a condenser, and to the case of damped trains of high-frequency, *i.e.* to Hertz waves in general. The theoretical value (R''/R') for the ratio of equivalent resistances to waves, respectively with and without damping, agrees very well with Dr. Barton's experimental results.—Mr. Oliver Heaviside, in a communication (here abstracted), said that he had by another method of mathematical analysis arrived at the same value as Dr. Barton for (R''/R'). In addition to the causes hitherto suggested as affecting the attenuation factor, it was possible that the conductivity of the wires to vibrations millions per second, might be less than with steady currents, and that the voltage at the beginning of the wave-train might be large

enough to cause some leakage. Both resistance and inductance become infinite with infinite damping, and they differ somewhat from the corresponding quantities for undamped waves.—Mr. Rollo Appleyard then described (1) some experiments upon dephlegmators, in which he has attempted to replace the platinum-gauze valves of the ordinary fractionating-tubes by bends in the tubes. The general form of the apparatus consists in a series of elongated bulbs, the top of each being connected to the bottom of the one above it by a horizontal S-shaped tube. The vapour condensed in any intermediate bulb falls back into the preceding S-bend. The first portions of the distillate are thus returned to the boiling-flask, leaving a little at each bend to act as a wash for the ascending vapour. At the early stage of distillation the bulbs and bends behave as required, but it is found that at the later stages certain of the bulbs become completely filled with liquid sustained by the upward pressure of the vapour, and unless the heating is very carefully managed "Geyser" actions may take place. Some arrangement of overflow tubes is therefore required for the bulbs. Mr. Appleyard also exhibited (2) a temperature tell-tale, to be used in connection with vats and for other purposes where an alarm is to be sounded by making electric contact when temperature rises or falls beyond certain limits. A J-shaped glass tube has its short limb sealed and its long limb open. Water or other suitable liquid is poured in, completely filling the short limb. Mercury is then made to displace nearly all the water in the short limb; the surplus water in the long limb is removed by a pipette, and the mercury is adjusted to a convenient level. Two platinum contact-wires are sealed into the glass at a short distance above the free surface of mercury in the long limb. The tube may be half an inch in diameter, with a long limb of 5 inches, and a short limb of 2½ inches. The quantity of mercury in the tube is generally arranged so that at temperatures below the boiling-point of the contained liquid, the mercury level is lowest in the long limb. In this case, if the temperature is raised to the boiling-point of the contained liquid, the mercury assumes approximately a common level in both limbs, for at the boiling-point of the liquid, under these conditions, the vapour-pressure is equal to the barometric pressure. Hence, the liquid and the mercury are not spurted out. Mr. Whopple said that when working with an ordinary "thermometer" tube, the contacts were inefficient owing to oxidation. Moreover the mercury column broke up, and in some cases mercury clung to the contact-wire. He asked if these difficulties occurred in Mr. Appleyard's apparatus. Mr. Watson suggested that in some cases the long limb might with advantage be closed. With regard to the dephlegmator he thought that the bends should each be duplicated by a short tube, so as to provide one path for the descending liquid and another for the ascending vapours. This seemed to be the object of the platinum gauze in fractionating-tubes. Mr. Appleyard, in reply, explained that the change of level in the "tell-tale" was a sudden rise of about an inch of mercury, in a tube half an inch in diameter. This rise was able completely to envelope the contact wires, surface oxidation could not affect the working, and there could be no such thing as failure of contact. Moreover, the tube was too wide for mercury to be held up by capillarity. The large area of contact enabled the instrument to be used for strong currents. The cost was small, and the only adjustment consisted in choosing a liquid of suitable boiling-point; for the platinum wires could be sealed in anywhere in the long limb; about two and a half inches from the bottom was a good position for them. The sudden rise occurred when the temperature was one or two degrees above the boiling-point of the contained liquid.—Mr. T. H. Littlewood then read a paper on the volume-changes which accompany solution, and described an apparatus for measuring the contraction observed when solids are dissolved in a liquid. Two glass bulbs are arranged one above the other, so that liquid can pass from the upper one to the lower one through a stop-cock, and from the lower one upwards into the neck of the upper one through a second stop-cock. This neck, which forms the top of the upper bulb, is fitted with an india-rubber stopper. The lower bulb is tubulured, and provided with a glass stopper. A horizontal capillary tube is fitted into the india-rubber stopper, so that volume changes can be determined, after the manner of using Bunsen's calorimeter. The weighed solid is introduced at the tubulure. The measured amount of water is poured in at the neck. Paraffin oil is now poured in at the tubulure so that the apparatus is completely filled: the lower bulb with the solid and the oil, the upper bulb with the water. The apparatus is then exhausted, and finally it is placed in a tank of water at constant temperature. When the stop-cock between the bulbs is opened, solution begins, and the resulting contraction is measured. For small amounts of salt dissolved in constant volume of liquid, the contraction is very nearly proportional to the amount of salt. For larger amounts, the contraction is greater in proportion than the added salt. If a strong solution is gradually diluted, then for equal amounts of water added, the contraction becomes smaller for successive amounts of added water. Mr. Littlewood applies Ostwald's theory, and the theory of Van der Waals to the observed results, and expresses the contraction as a logarithmic function of the volumes and the internal pressures. Mr. Lehfeldt thought the india-rubber stopper was a weak point in the apparatus. With regard to the theory of the contraction, Tammann (*Zeitschr. für Phys. u. Chem.*, 1895), had given an expression which was rather more intelligible. Tammann found that the effect could be regarded as equivalent to a change of pressure, and by attributing this quality to the solution, the characteristic surface becomes the same as that for water. The volume of the solution would thus follow similar changes to those that water undergoes with increasing pressures. Prof. Ewing said the experiments reminded him of the very first piece of research work he had done in physics, which was twenty-five years ago, on the same problem, with Mr. McGregor. An examination of the electrical properties of solutions of certain salts led to an investigation of their changes of density and volume. In some cases the contraction observed was so great that the volume of the solution was less than the original volume of the water to which the salt had been added. They made some measurements, but the apparatus they had used was very rough compared to that described by Mr. Littlewood. Mr. Watson asked whether Mr. Littlewood had made any simultaneous density measurements. There were some solutions for which the contractions and corresponding densities had been worked out. By examining successive dilutions of strong solutions, and the corresponding densities, a check might be made as to the numerical results obtained by Mr. Littlewood's apparatus. Dr. Chree suggested that in place of the logarithmic expression, the total contraction might possibly be better represented by a few terms of a series involving increasing powers of the difference of volume, each term being multiplied by a proper constant. Mr. Littlewood, in reply, said that the india-rubber stopper possessed advantages in regulating the height of the capillary tube. It did not introduce sensible error, for it was possible to work with it to a centigram of mercury in the capillary. On the other hand temperature-changes of one-tenth of a degree involved one centigram more or less of mercury in the tube. Bunsen, using an india-rubber stopper, obtained very accurate results in calorimetry.

Zoological Society, January 17.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Dr. F. P. Moreno exhibited and made remarks upon the original specimen of the recently-described Mammal *Neomylodon listai*, which he believed to be a portion of the skin of one of the old Pampean Mylodons now quite extinct.—Mr. Sclater read some extracts from letters recently received from Mr. J. S. Budgett, who had been sent by the Council on a scientific mission to the Gambia.—Mr. Alfred H. Cocks, exhibited some living specimens of supposed hybrids between the stoat ♂ and ferret ♀.—Mr. R. E. Holding exhibited and made remarks upon some deformed antlers of a fallow deer and of an axis deer. The abnormality in the former was thought to be due to imperfect formation of the "burr," and that of the latter to continued bad health.—Mr. G. E. H. Barrett-Hamilton exhibited some skins of continental squirrels which showed remarkable seasonal changes in coloration, and pointed out their differences from British specimens.—Dr. Arthur Willey gave an account of his itinerary, in the years 1894 to 1897, while in search of the eggs of the pearly nautilus. His travels took him to New Britain, New Hanover, New Guinea, Sydney, New Caledonia, the Loyalty Islands, and elsewhere. In addition to results connected with the main object of the journey, the author described a number of collateral results which were of special interest. These related largely to animals which occupy a low position in the scale of the animal kingdom, and represent vestiges of what were in all probability predominant

types in former ages, such as *Balanoglossus*, *Amphioxus*, and *Peripatus*. These creatures were of great interest in respect of their geographical distribution, a subject which was dealt with in the paper. The paper was illustrated by lantern slides portraying some of the author's captures and the methods employed in procuring his material.—Prof. D'Arcy Wentworth Thompson, C.B., read a communication on characteristic points in the cranial osteology of the parrots. The orbital ring, the auditory region, the quadrate bone, and other minor characters were described in about forty genera. *Stringops*, in regard especially to its quadrate bone, seemed to be the most primitive form. *Nestor* was in several respects still more divergent from the rest, though its divergent characters were not necessarily primitive.—A communication was read from Miss Isa L. Hiles, containing a report on the Gorgonacean corals collected by Mr. J. Stanley Gardiner on Funafuti. The collection contained specimens of two new species, viz. *Acamptogorgia spinosa* and *Villegorgia rubra*, and of other species, some of which were of interest as having been described previously only from localities far removed geographically from Funafuti.—A communication was read from Mr. Arthur E. Shipley, containing notes on a collection of Gephyrean worms obtained on Christmas Island by Mr. C. W. Andrews. One species of Echiuroid and five of Sipunculoid worms were treated of in this paper.—A communication was read from Mr. James Yate Johnson, containing notes on the *Coralliidae* of Madeira, and descriptions of two new species, viz. *Pleurocorallium tricolor* and *P. maderense*.

Royal Meteorological Society, January 18.—Mr. F. C. Bayard, President, in the chair.—The Council in their report stated that, owing to the premises now occupied by the Society at 22 Great George Street, being required by the Government, they had been obliged to seek accommodation elsewhere, but not being able to secure offices in the immediate neighbourhood, they had taken a suite of rooms at 70 Victoria Street.—Mr. Bayard, in his presidential address, gave an account of the government meteorological organisations in various parts of the world. He first briefly described the founding of each system, and mentioned the names of the various directors, and then enumerated the number of observing stations associated with each organisation. In most countries forecasts of the weather are issued, and Mr. Bayard gave some interesting particulars as to the success attained by each office. The amount of money voted by the various governments for the support of meteorology showed what a very small portion of the revenue of the different countries goes towards the promotion of this science. In the British Isles it is two shillings and sixpence per square mile, but only about one-third of a farthing per head. The address was illustrated by a large number of lantern slides showing views of the various observatories and portraits of the directors. Mr. Bayard was re-elected president for the ensuing year.

Royal Microscopical Society, January 18.—Annual Meeting.—Mr. E. M. Nelson, President, in the chair.—After the report of the Council for the past year and the Treasurer's statement of accounts had been read and adopted, the President announced that the following were elected as officers and Council for the ensuing year:—President: E. M. Nelson. Vice-Presidents: A. W. Bennett, G. C. Karop, the Hon. Sir Ford North, J. J. Vezey. Treasurer: W. T. Suffolk. Secretaries: Rev. Dr. W. H. Dallinger, Dr. R. G. Hebb. Ordinary Members of Council: J. M. Allen, C. Beck, Dr. R. Braithwaite, Rev. E. Carr, W. Carruthers, T. Comber, E. Dadswell, A. D. Michael, T. H. Powell, C. F. Rousselet, Dr. J. Tatham, Rev. A. G. Warner. Curator: C. F. Rousselet.—The President then delivered the annual address; the first portion was a review of the work of the past year, in the course of which he congratulated the Society on its improved position, the second portion was a paper on dispersion, in which he discussed some formulæ necessary in constructing achromatic lenses; diagrams and tables in illustration of the subject being thrown upon the screen.

Chemical Society, January 19.—Prof. Dewar, President, in the chair.—The following papers were read:—Researches on moorland waters (1), by W. Ackroyd. The author distinguishes between organic and inorganic acidity in moorland waters; their amounts are determined by (1) titration with N/100 alkali, and (2) titration in a sample freed from carbon dioxide by aspiration of air.—Esterification constants of substituted acetic acids, by J. J. Sudborough and L. L. Lloyd. From the authors' experiments it appears that the rate of esterification of an acid depends on the constitution of the acid rather than its strength.—Diortho-substituted benzoic acids. Part iv. Formation of salts from diortho-substituted benzoic acids and different organic bases, by L. L. Lloyd and J. J. Sudborough. The authors are attempting to determine whether the capacity to form salts is dependent on (1) the strength of the acid and of the base, or (2) the constitution of the acid and of the base or on both of these.—α-Ketotetrahydronaphthalene, by F. S. Kipping and A. Hill. Under suitable conditions phenylbutyric chloride is converted by aluminium chloride into α-ketotetrahydronaphthalene by intermolecular condensation.—A new method for preparing unsymmetrical dimethyl- and trimethyl-succinic acids, by W. A. Bone. Ethylic sodiocyanoacetate when heated with alcoholic ethylic α-bromoisobutyrate yields unsymmetrical ethylic dimethylcyanosuccinate $(CO_2Et)CH(CN).CMe_2.CO_2Et$, which on hydrolysis yields the corresponding dimethylsuccinic acid; the sodio-derivative of the dimethylcyanosuccinate yields ethylic trimethylcyanosuccinate with methylic iodide.—Production of optically active mono- and di-alkyloxysuccinic acids from malic and tartaric acids, by T. Purdie and W. Pitkeathly. Alkylation by means of alkylic iodides and silver oxide is generally applicable to the ethereal salts of hydroxy-acids. As racemation does not occur in the process, it is specially adapted for the preparation of optically active compounds.—The action of ammonia on ethereal salts of organic acids, by S. Ruhemann. Ethylic phenylpropenetricarboxylate when treated with ammonia yields ethylic γ-phenyl-αα′-dihydroxy-β-carboxylate and phenyldihydroxypyridine; similarly ethylic phenylbenzylglutaconate yields γ-phenyl-β-benzyl-αα′-dihydroxypyridine.—The changes of volume due to dilution of aqueous solutions, by E. B. H. Wade.—The thermal effects of dilution, by J. H. Pollok.—Halogen derivatives of acetonedicarboxylic acid; Part i., by F. W. Dootson. Ethylic acetonedicarboxylate is converted by dry chlorine into ethylic tetrachloracetonedicarboxylate.—The detection and determination of sucrose in the presence of lactose, by E. Dowzard. The author determines sucrose in presence of lactose by taking advantage of the fact that sucrose is inverted by citric acid whilst lactose is not.—Note on the interaction of formaldehyde with β-naphthylamine derivatives, by G. T. Morgan.

Geological Society, January 18.—W. Whitaker, F.R.S., President, in the chair.—On a small section of felsitic lavas and tuffs near Conway (North Wales), by Frank Rutley. The rocks described in this communication were collected in 1877, in series, at short intervals, from a point at the mouth of the river Conway, near Bodlondeb. They consist of felsitic lavas and tuffs, sometimes nodular, and generally exhibiting some variety of fluxion-structure, corrugated, or banded. A specimen showing brown bands is compared with one described by Iddings from the Yellowstone Park. What were once possibly red bands are now represented by devitrified brown glass, and the change in colour may have been due to the action of water upon the ferric oxide which originally gave its colour to the glass. Some of the rhyolites are tufaceous, and envelop fragments of rocks, some of which were originally vitreous, others lithoidal. Coarser rhyolitic tuff occurs at the northern end of the series.—The geology of Southern Morocco and the Atlas Mountains, by the late Joseph Thomson. This paper gives the results of observations made under considerable difficulties during a journey in Morocco in 1888. The tract traversed is roughly triangular, the base being the Atlantic Ocean between Saffi and Agadir, and the apex the district of Demnat, on the northern slopes of the Atlas, some sixty miles east of the city of Morocco. This district consists of three main sections: (1) The coast lowlands; (2) the plateau in two chief steps, the northern rising to 2000 and the southern to 5000 feet; (3) the Atlas itself, which only begins to be a mountain-chain about thirty miles from the coast, and which ranges first east-by-north and then north-east in its central and loftiest part. (1) The lowlands are practically conterminous with the Tertiary deposits, among which apparently Eocene, Miocene, and Pliocene rocks are represented. The latter consist of shelly sands 200 to 300 feet thick, gradually rising to a height of 700 feet south and east of Saffi. Their surface is often covered with the slaggy tufaceous crust described by Maw. (2) The plateau is underlain by three rock-formations: (*a*) Metamorphic rocks, including clay-slates, which probably underlie the whole Plain of Morocco, and rise into a group of rugged hills called the "Jebelet," in contradistinction to the "Jebel," or Atlas proper. (*b*) The Lower Cretaceous rocks, consisting of red shales and sandstones, the

former frequently giving rise to brine springs and containing salt deposits at Demnat in the Atlas. (*c*) The Upper Cretaceous rocks, chiefly white and cream-coloured limestones, which attain their greatest development on the plateau. (3) The Atlas itself is made up for the most part of the same rocks. There is a core of metamorphic rocks, which is better developed and wider at the western end of the range and narrower towards the east. Next comes the great development of the Lower Cretaceous strata, followed by a diminutive representative of the Upper Cretaceous rocks. These rocks are much broken by folding and faulting, and their structure is displayed in several sections taken across the range from Demnat westward. The first signs of glacial action were met with at Titula, consisting of moraine-like heaps of débris ; elsewhere, scratched stones were found.

DUBLIN.

Royal Dublin Society, December 21, 1898.—Prof. T. Preston, F.R.S., in the chair.—Mr. J. E. Duerden, of Kingston, Jamaica, communicated a paper giving an anatomical description of ten species (seven Stichodacylinæ and three Zoantheæ) of Jamaican Actiniaria. A new genus, *Heliktanthus*, is erected for the *Actinia anemone* of Ellis, and included along with the genera *Ricordea* and *Actinoporus*, under the family Discosomidæ. Three species of *Parazoanthus* are all new.—Prof. T. Johnson gave an account of the different kinds of peat and their products, including a set of continental specimens recently added to the Botanical Department of the Science and Art Museum, Dublin.—Prof. James Lyon presented a note on the reversal of the photographic image, with lantern illustrations.—Dr. Gerald Molloy read a paper on the use of the vertical wire in Mr. Marconi's system of signalling through space, by means of electric waves. Mr. Marconi had found that by using a long vertical wire in connection with the oscillator at the sending station, and a similar wire in connection with the resonator at the receiving station, he was able to increase the distance over which intelligible signals could be sent, from a few hundred yards to fourteen miles and more. But the curious thing was that the wire was quite ineffective if placed horizontally. To account for this, Dr. Molloy proposed a theory, founded on the principle of electric images. He showed that, whether the wire was placed horizontally or vertically, the oscillations of the discharge were accompanied by oscillations of the electric image, and that each set of oscillations sent out waves into space. But there was this difference between the two cases : when the wire was horizontal, the waves sent out by the oscillations of the image were in opposite phase to those sent out by the oscillations of the discharge, and therefore tended to extinguish them ; whereas when the wire was vertical, the two sets of oscillations were in the same phase, and tended to reinforce each other.—Mr. Ernest A. W. Henley presented a preliminary note of a method of measuring the relative opacities of various organic substances to the X-rays. He found the numbers representing the relative opacities of bone, muscle, and fat to be 4, 2·5, and 1. These results were obtained by comparing X-ray photographs of wedge-shaped pieces of the substances placed side by side, and finding two points, one in each wedge, which had the same depth of colour. The thickness of each wedge at the point found in it was measured, and hence the ratio of the opacities was determined.—Prof. G. F. Fitzgerald, F.R.S., read a paper on a hydrodynamical hypothesis as to electromagnetic actions. The paper is an attempt to extend Lord Kelvin's papers on the propagation of laminar motion in a turbulent liquid in the *Phil. Mag.*, 1887, vol. xxiv. p. 342, and which he there illustrated by separate vortex rings in the case of long vortex filaments, such as Lord Kelvin described in a paper on vortex filaments surrounded by a tore (*R. I. Acad. Proc.*, ser. iii., 1889, vol. i. p. 340). It appears as if electric force should be represented by a helical condition of the filaments, which would be propagated with another accompanying motion which represents magnetic force. An electron should then be the irregular point where two helices wound in opposite directions meet.

PARIS.

Academy of Sciences, January 23.—M. van Tieghem in the chair.—Some remarks on the prolongation of functions, by M. Emile Picard.—On some properties of aluminium, by M. A. Ditte. The results of experiments on the corrosion of aluminium by saline solutions show that the metal is at first vigorously attacked, but that a coherent protective layer of alumina is soon formed. In presence of air, however, the corrosion goes on, and if an aluminium plate has been immersed in a salt solution and then only imperfectly washed, the attack slowly continues, the surface becoming more easily attacked by other reagents.—Histology of the skin. Some histo-chemical reaction of eleidine, by M. L. Ranvier. The fragment of skin is left for ten hours in a ten per cent. solution of common salt, then hardened in alcohol, and the sections stained with picrocarmine. A uniform red tint is observed at the level of the *stratum granulosum*, the granules of eleidine being completely diffused. In this way it can be shown that the epidermal cells lose their granular eleidine sharply in passing from the *stratum granulosum* into the *stratum intermedium*.—On the formation of pollen and the chromatic reduction in *Nais major*, by M. L. Guignard. The numerical reduction appears only at the instant when the pollen mother-cell commences to divide up into the four pollen nuclei.—Researches on the chemical state of the elements contained in steels. Double carbides of iron and other metals, by MM. Ad. Carnot and Goutal. The carbides $Fe_3C.WC.$, $Fe_3C.Mo_2C$, $2Fe_3C.Mn_3C$, $Fe_3C.2Mn_3C$, and $Fe_3C.4Mn_3C$ were isolated from steels containing tungsten, molybdenum, and manganese. — The first voyage of the *Princess Alice II.*, by Prince Albert I. of Monaco. A *résumé* of the scientific results of the voyage in the polar seas during the summer of 1898. The majority of the specimens were collected in the northern Norwegian fjords and at Spitsbergen.—Prof. Mendelejeff was elected correspondant in the Section of Chemistry, in the place of the late Prof. Kékulé.—Observation of the total eclipse of the moon of December 27, 1898, made at the Observatory of Besançon, by M. L. J. Gruey. —Observations of the planet 1898 ED (Charlois), and of the Chase comet, made at the Observatory of Besançon, by M. P. Chofardet, by M. L. J. Gruey.—On some photographs of nebulæ and star clusters, obtained at the Observatory of Meudon, by M. Louis Rabourdin. The paper is accompanied by seven reproductions of photographs of nebulæ and of the great Hercules star cluster.—Generalisation of Jacobi's first method of integrating partial differential equations, by M. N. Saltykow. —On groups of operations, by M. G. A. Miller.—On the development of certain surds in continued fractions, by M. Crelier.—On the deformation of some quadrics of revolution, by M. C. Guichard.—On the normal equation of surfaces, by M. A. Pellet.—On the expression of the energy of a circuit and the law of the electromagnet, by M. A. Perot.—On the chemical action of the X-rays, by M. P. Villard.—Action of oxidising agents on some aromatic compounds, by MM. Œchsner de Coninck and A. Combe. A continuation of work previously described. Nitrogen gas was evolved on oxidation with chromic acid in only one case, that of picramic acid.—Action of iodine monochloride upon monochlorobenzene in presence of anhydrous aluminium chloride, by M. A. Mouneyrat. Iodine monochloride acts readily upon chlorobenzene in presence of aluminium chloride at 60° C. The main product of the reaction is *p*-iodochlorobenzene, small quantities of dichlorobenzene and trichlorobenzene being obtained as bye-products.—Studies in filtration ; organic liquids, by M. J. Hausser. The filtering layer in these experiments was composed either of kaolin, calcium phosphate, or animal charcoal. The filtering layer was not changed by the successive passage of different liquids. The relative velocities of filtration for a given liquid are not altered by a change in the filtering material.—Biochemical oxidation of propane glycol, by M. André Kling. Propane glycol is oxidised by the sorbose bacteria to either acetol or pyruvic aldehyde, the osazone of which was isolated.—On some cellular bodies in the organism of a vertebrate, by M. P. Stephan.—Researches on the anal glands of the *Carabidae*, by M. L. Bordas.—On the mechanism of flight in insects, by M. Charles Janet.—Relations between the intensity of the green coloration of leaves and assimilation by chlorophyll, by M. Ed. Griffon. It is not always possible to predict the intensity of chlorophyllian assimilation by the intensity of the green coloration in fully-developed leaves. In some cases leaves having the same tint have different assimilating powers, and in others the pale leaves may assimilate more strongly than the darker leaves.—On the primordial leaves in *Cupressus*, by M. Aug. Daguillon.—On the structure of the bundles of the placenta in the genus *Primula*, by M. E. Decrock.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 2.

ROYAL SOCIETY, at 4.30.— Sets of Operations in relation to Groups of Finite Order: A. N. Whitehead.—Note on the Enhanced Lines in the Spectrum of α Cygni: Sir J. N. Lockyer, F.R.S.—The Constitution of the Electric Spark: Prof. A. Schuster, F.R.S., and G. Hemsalech.—On the Effects of Strain on the Thermo-electric Qualities of Metals: Dr. Magnus Maclean.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor.

LINNEAN SOCIETY, at 8.—Notes on the Genus Nanomitrium, Lindberg: E. Stanley Salmon.—On the Production of Apospory by Environment in *Athrium Filix-foemina*, var. *unco-glomeratum*, an apparently Barren Fern: Dr. F. W. Stansfield.—On the Genus Lemnalia, Gray, with an Account of the Branching System of the Order Alcyonacea: Gilbert C. Bourne.

CHEMICAL SOCIETY, at 8.—(1) Maltodextrin, its Oxidation Products and Constitution; (2) On Attempts to prepare Pure Starch Derivatives through their Nitrates: Dr. H. T. Brown, F.R.S., and J. H. Millar.—An Isomeride of Amarine: Dr. H. Lloyd Snape and Dr. Arthur Brooke.—Propylbenzenesulphonic Acids: Dr. G. T. Moody.—Derivatives of Dibenzylmesitylene: W. H. Mills and T. H. Easterfield.—On the Action of Chlorosulphonic Acid on the Paraffins and other Hydrocarbons: Dr. Sydney Young, F.R.S.—(1) The Action of Reducing Agents on Nitrogen Iodide; (2) The Action of Acids upon Nitrogen Iodide: F. D. Chattaway and H. P. Stevens.—The Composition of Nitrogen Iodide: F. D. Chattaway.—(1) The Preparation and Properties of Nitrogen Iodide; (2) The Action of Light upon Nitrogen Iodide; (3) The Action of Alkaline Hydrates, of Water, and of Hydrogen Peroxide upon Nitrogen Iodide; (4) Theory of the Formation and Reactions of Nitrogen Iodide: F. D. Chattaway and Kennedy J. P. Orton.

FRIDAY, FEBRUARY 3.

ROYAL INSTITUTION, at 9.—The Roman Defences of South-East Britain: Prof. Victor Horsley, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual Meeting.—Address by the President, J. J. H. Teall, F.R.S.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, FEBRUARY 6.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—Explorations in Fiordland, New Zealand: Hon. Thomas Mackenzie.

VICTORIA INSTITUTE, at 4.30.—Protection among Animals: Dr. W. Kidd.

TUESDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Cerebral Convolutions of the Gorilla: F. E. Beddard, F.R.S.—Note on the Presence of Supernumerary Bones occupying the place of Prefrontals in the Skull of certain Mammals: Dr. R. O. Cunningham.—On the Mice of St. Kilda: G. E. H. Barrett-Hamilton.—Notes on *Notornis*: Prof. W. Blaxland Benham.

RÖNTGEN SOCIETY, at 8.—A Modified Form of Toepler Mercury Pump: Wilson Noble.—Discussion on the Röntgen Ray Photography of Soft Tissues, introduced by the President.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be read and discussed: The Waterworks of the Madras Presidency: J. A. Jones.——And, time permitting: The Lake Superior Iron Ore Mines, and their Influence upon the Production of Pig Iron and Steel: Jeremiah Head and Archibald P. Head.

WEDNESDAY, FEBRUARY 8.

SOCIETY OF ARTS, at 8.—Nernst's Electric Light: James Swinburne.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Reflection of Cathode Rays: A. A. C. Swinton.—On the Recovery of Iron from Overstrain: James Muir.—A Soil Bacillus of the Type of De Bary's *B. megatherium*: Dr. W. C. Sturgis.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

MATHEMATICAL SOCIETY, at 8.—On a certain Mineral Surface and on a Solution of $\nabla^2 V = 0$: T. J. Bromwich.—The Group of Linear Homogeneous Substitutions on mq Variables which is defined by a certain Invariant: Dr. L. E. Dickson.—On the Complete System of Differential Covariants of a Single Pfaffian Expression, and of a Set of Pfaffian Expressions: J. Brill.—Groups of Order p^3q: E. A. Western.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.—(Continuation of Discussion, if time permits: Electric Traction by Surface Contacts: Miles Walker.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at 9.—Motion of a Perfect Fluid: Prof. H. S. Hele-Shaw.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—An Ampere-Meter and a Volt-Meter with a Long Scale: Benjamin Davies. (This will probably be read by Dr. Lodge.)

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Electrical Driving of Engineering Workshops: William Middleton.

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Sanatoria for Consumptives: Dr. F. R. Walters (Sonnenschein).—L'Industrie du Goudron de Houille: Dr. G. F. Jaubert (Paris, Gauthier-Villars).—The Tōkyō Imperial University Calendar, 1897–98 (Tōkyō).—Die Spiele der Menschen: Prof. K. Groos (Jena, Fischer).—Photography: A. Brothers, 2nd edition (Griffin).—A Text-Book of Physics: Profs. Poynting and Thomson, Sound (Griffin).—Dictionary of Medical Terms: H. de Meric (Baillière).—Notes on Cage Birds: edited by Dr. W. T. Greene, 2nd series (Gill).—Wonders of the Bird World: Dr. R. B. Sharpe (Gardner).—The Valley of Light: W. B. Worsfold (Macmillan).—In the Australian Bush, &c.: R. Semon, translated (Macmillan).—An Illustrated School Geography: A. J. Herbertson (Arnold).—Calendario del Santuario di Pompei, 1899 (Valle di Pompei).—Continuous-Current Dynamos: J. Fisher-Hinnen (Biggs).—Traité Elémentaire de Météorologie: Prof. A. Angot (Paris, Gauthier-Villars).

PAMPHLETS.—The Triassic Formation of Connecticut: W. M. Davis (Washington).—A Table of the North American Tertiary Horizons: W. H. Dall (Washington).—The Dolmens of Japan and their Builders: W. Gowland (Clowes).

SERIALS—School World, January (Macmillan).—A Manual of the Geology of India, 2nd edition, Part 1 (Calcutta).—Astrophysical Journal, December (Chicago).—National Geographic Magazine, December (Washington).—Physical Review, December (Macmillan).—Zoologist, January (West).—Agricultural Gazette of New South Wales, November (Sydney).—Journal of the Sanitary Institute, January (Stanford).—Quarterly Review, January (Murray).—Journal of the Chemical Society, January (Gurney).—Archives of the Roentgen Ray, November (Rebman).—Journal of the Franklin Institute, January (Philadelphia).—American Naturalist, January (Ginn).—Popular Astronomy, January (Wesley).—The Technology Review, January (Boston)—Chambers's Journal, February (Chambers).—Good Words, February (Isbister).—Sunday Magazine, February (Isbister).—American Journal of Mathematics, January (Baltimore).—Century Magazine, February (Macmillan).

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