THURSDAY, NOVEMBER 18, 1897.

THE MATHEMATICS USED IN CONNECTION WITH PHYSICS.

The Theory of Electricity and Magnetism; being Lectures on Mathematical Physics. By A. G. Webster, Assistant Professor of Physics, Clark University, Webster, Massachusetts. Pp. xii + 571. (London: Macmillan and Co., Ltd., 1897.)

THE aim of the writer, according to the preface, in the preparation of this volume has been to present to the students the results of the Maxwellian theory as it stands at present, after the labours of Faraday, Maxwell, Helmholtz, Hertz, and Heaviside.

Prof. Webster is a somewhat young man of marked promise, whose contributions to the discussions in Section A of the British Association formed one of the features of the meeting of that section at Toronto this year, and the book shows that he is fully capable of appreciating the mathematical significance of physical facts. It is doubtful, however, whether a student would be able to appreciate the physical significance of the mathematical theory from reading it. Possibly the students of the Clark University, when listening to such lectures as are given in this treatise, have the physical meanings of the various mathematical processes explained to them. If not, they must possess an exceptional amount of ability to enable them to arrive at correct physical interpretations of the mathematical equations.

The first fifty-two pages of the book are occupied with a short summary of the principles of the vector calculus, the definitions of variables, functions, differential coefficients, definite integrals, line and surface integrals, something about the calculus of variations, &c. It is not quite obvious what is the object of giving this, since a student who was capable of following the book would understand the meaning of a differential coefficient before opening it; or if, on the other hand, he was ignorant of the differential and integral calculus, he would require far more detailed information than is given in these fifty-two pages before he could tackle triple integrals, vector differential operators, &c., which are used quite early in the book.

Is it correct to say that, "following the usage of the majority of writers, we shall denote

$$\frac{\delta^2}{\delta x^2} + \frac{\delta^2}{\delta y^2} + \frac{\delta^2}{\delta z^2}$$

by Δ," seeing that many writers, including Thomson and Tait, use ∇^2, and Maxwell $-\nabla^2$?

Gauss' theorem may undoubtedly be stated as a piece of mathematical analysis, as it is done on pp. 75–78; but the theorem would be perfectly useless if gravitational, electric, and magnetic forces did not vary as the inverse square of the distance. When, therefore, the theorem is divorced from all physical application or interpretation, is not the student less likely to grasp it and to remember it?

The last section of the introductory chapter, which brings us to p. 91, discusses the theory of functions of a complex variable with clearness and conciseness; and this section might with advantage have been extended, and some of the earlier portion of the book omitted.

Part i., which commences on p. 91, is on the "Theory of Newtonian Forces"; but forces as realities, and not merely letters which satisfy a number of equations, have not much existence in the chapter. Take, for example, d'Alembert's principle described on p. 107 This principle is in reality the result of an argument based on Newton's laws, and leads to a valuable set of equations in dynamics. The reader, however, is not told this, but only that the analytical statement of d'Alembert's principle is given in Lagrange's equation of virtual velocities. This equation, Mr. Webster rightly states, involves all the internal forces, and so the student might not suspect that the essence of d'Alembert's principle was the elimination of these internal forces.

The rest of the Part i. is good, the subject of attractions being well and lucidly treated. Does not, however, the introduction of the n axes of the harmonic of the nth degree add unnecessary difficulty, and somewhat hide the beauty of harmonic analyses? For students who already possess a good knowledge of magnetism, the treatment of polarised distributions will be useful.

Although the title of this book, as given on the cover, is "Electricity and Magnetism," it is not until p. 243, or nearly the middle of the book, that we come to the portion that deals specially with electricity. The statement of the general problem of electrostatics, as given at the beginning of § 135, is insufficient since, as pointed out, any number of solutions could be given to it. The method, however, which is indicated for the solution of the problem is correct, and leads in a neat way to the conception of coefficients of induction from which the coefficients of potential are deduced.

§ 151, on Green's function, like much of the matter in the book, is divorced from its physical application, so that a student will hardly see the physical nature of the problem that Green set himself to solve, or the method by which he solved it. In fact, the author criticises Green's work as follows:—

"Reasoning depending on such physical facts was frequently made use of by Green, and while not legitimate for purposes of mathematical demonstration, is frequently of service to the physicist."

The discussion, however, of the application of conjugate functions is good.

It is not the custom in this country to call the conductor of a Wheatstone's bridge, in which the galvanometer is inserted, "the bridge wire," and we are not aware that this practice is followed in America either.

On page 357 the author defines μ as the *inductivity* of the medium, and explains that this becomes specific inductive capacity in the electric case, and permeability in the magnetic. This analogy is, of course, quite correct, but it is carried too far when the same letter μ is used for specific inductive capacity on some pages and for magnetic permeability on others. In considering the dimensions of the electrostatic and electromagnetic systems of units, the propagation of waves, &c., the beginner

might expect to find μ instead of which he finds $\epsilon\mu$; the meaning, however, of this ϵ does not seem to be given, and he is left to discover for himself that this ϵ stands for the specific inductive capacity for which μ has been previously employed.

We should prefer to say that the *absolute* dimensions of specific inductive capacity and of permeability were yet unknown rather than they were "arbitrary," and we do not agree with the statement that attempts to settle their absolute dimensions are evidently based upon misconceptions of the theory of dimensions.

The statement that "for magnetic bodies as the force increases μ diminishes" is generally correct, but not sufficiently guarded, seeing that the very opposite is the case for small forces; and more explanation is required as to the meaning, or the necessity, of the statement:—"The variability of μ does not affect the validity of Ohm's Law, which determines the distribution of the laws of induction."

The last chapter in Part ii., on the conduction in dielectrics, contains some interesting work, such as that on the effect of heterogeneity.

Part iii. deals with the electromagnetic field in a lucid and satisfactory manner. We feel somewhat divided in our judgment regarding Mr. Webster's inability to respond to Boltzmann's appeal that Maxwell's notation should be followed. It will undoubtedly be somewhat perplexing for the student to have to employ X, Y, Z for the components of electric field intensity when he reads this book, and for the components of a mechanical force when he is studying Maxwell's classical treatise. But Mr. Webster is an American, and the secret of the success of his countrymen lies in their having gone ahead instead of merely following precedent. Hence, whatever may be the wrench we feel at being torn away from our time-honoured notation, we must respect Mr. Webster's independence in employing what he considers a better one.

The book finishes with an excellent introduction to the theory of electromagnetic waves, which deals with the more important points of this subject in a clear and concise manner. The statement made on page 550, that the matter on the preceding seventeen pages applies only to a submarine cable of infinite length, should have come much earlier; for, on reading these pages, we certainly thought that the author was under the mistake of imagining that the treatment applied equally well to a finite cable.

On page 536 the author pokes fun at established authority by giving more than one reason why long-distance telephony has not existed in England, and on page 547 he sits in judgment on Mr. Heaviside in an equally humorous way, although in this case the fun is not intentional on the part of the author.

The book is on the whole distinctly good, and any one who has mastered it will possess a sound acquaintance with the most important parts of mathematical electricity. The absence of reference to experimental methods is, as stated in the preface, intentional, and, of course, no practical applications of electricity are referred to. But, even if this system has been followed as a protest against those who forget that the practice of to-day was the theory of yesterday, we would suggest that a course of "Lectures on Mathematical Physics" may fitly contain explanations of the physical interpretations of the equations developed without running the risk of appearing to pander to the needs of the electrical contractor. W. E. A.

THE ELECTRICAL PHENOMENA OF NERVE.

Lectures on Physiology. (First Series.) *On Animal Electricity.* By A. D. Waller, F.R.S., &c. Pp. viii + 144. (London: Longmans, 1897.)

AS Fullerian Professor of Physiology, Dr. Waller has published a series of lectures on the electrical properties of nerve, in which he tells us that his aim has been to give "an exposition of the principal data" relating to the subject. Such of these data as have been derived from his own experiments have been already made known by him in his published papers; but the physiological reader will find it much easier to appreciate their value, now that they are placed before him in connection with facts already known to him. A point of great scientific interest in Dr. Waller's work consists in the circumstance that he has adopted and strictly adhered to a uniform method of "testing" the physiological conditions of a nerve. The gratitude of the reader is further excited by the perspicuity with which the method itself and the first fruits of its application are described, as well as by a vividness of style which makes him feel as if he had been present at the demonstrations.

Dr. Waller's object is to prove that the phenomenon by which a separated nerve most strikingly shows its vitality—the negative variation of du Bois-Reymond—is also a measure and criterion of the physiological condition of the nerve. For this purpose he employs an automatic arrangement by which at regular intervals of a minute, the appropriate "stimulus" for producing this effect is applied to the nerve, at the same time that the electrical "response" made by the nerve is recorded photographically. The effect thus recorded—the negative variation just mentioned—is the *diminution* of the so-called nerve current, the amount of which diminution is indicated by the deflections of a galvanometer connected with the nerve in the usual way. Consequently, so long as the strength and duration of the stimulus (a succession of induction currents led through the nerve at a distance from the part under observation) remains constant, the perfect uniformity of the periodical deflection indicates that the state of the nerve is unaltered; and the effect of any other condition, as, *e.g.* acid or alkaline reaction, change of temperature, &c., manifests itself by augmenting or reducing the deflection. As evidence that the deflection itself is a "vital" one, that is, one belonging to the living nerve as such, it is shown that the transient loss of function which follows the action of the vapour of ether is accompanied by an equally transient disappearance of the normal electrical reaction of the nerve, and again, that the presence of carbon dioxide in the saturated atmosphere in which the nerve is placed for observation, even in the smallest quantity, augments in an equally remarkable way the power of the nerve to respond to stimulation.

In the third lecture Dr. Waller sets forth further interesting facts relating to the mode of action of carbonic acid gas, and compares it with the effects of repeated stimulation, drawing certain inferences as to the agency of this body in producing fatigue, which it would be out of place to criticise here.

The fifth and sixth lectures are devoted to the elucidation of certain changes in the electromotive properties of living nerve, to which half a century ago du Bois-Reymond applied the term electrotonus. Using the method of observing and recording the responses to periodical automatic stimulations already referred to, Dr. Waller demonstrates du Bois' extrapolar electrotonic currents in such a way as to enable the audience to judge of their correspondence with phenomena of the same kind observed in "core models" (*i.e.* cylindrical conductors of which the cores are metallic, the sheaths soaked with solutions of electrolytes), and finally proves, as before, with the aid of ether vapour, that although these phenomena resemble those of physical polarisation so closely, they are, notwithstanding, dependent on a vital activity which the nerve loses and recovers again when for a few minutes put to sleep by the anæsthetic. In the last lecture Dr. Waller goes into the rather more recondite phenomena of "polarisation increment and decrement." His mode of exposition of this subject is so original that one begins to fear that he is about to demolish the interpretation of these phenomena which has been given by his distinguished predecessors in this field of investigation. Happily it is not so. When the time comes for explaining, the instructed reader is gratified to find that although the terms employed are peculiar and unusual, there is nothing abnormal about the doctrine. "Active tissue is zincative, resting tissue is zincable." Consequently in a living nerve through a certain bit of which a battery current is flowing, the anode is more zincable than the kathode; for the living substance of the nerve is at rest at the anode, awake at the kathode. But what does zincable mean? It is a word which Dr. Waller proposes to introduce into scientific terminology because he cannot find an English equivalent for the German "leistungsfähig." Regarding the "Leistung" of a nerve to be chiefly electrical, its "Leistungsfähigkeit" is its "capability of being aroused to electromotive action" (p. 83)—a property which he emphatically distinguishes from "excitability," rightly holding that this word ought only to be used to denote the facility with which a response is evoked.

Dr. Waller's explanation of the increment and decrement is that the diminished excitability which is the well-known effect of the anode during the flow of a voltaic current along a nerve, is necessarily associated with what he calls increased zincability. Hence if the nerve passes from the electrotonic into the excited state, those parts which are most zincable are most susceptible of excitatory change. The point which is thus enforced—that is, the association of increased capability with diminished promptitude to reaction—is a fundamental one in the physiology of all excitable tissues. There can be no doubt that in relation to the phenomena now in question, it has been brought out in a more striking way than before by Dr. Waller's excellent forms of experiment, his lucid description, and the admirable diagrams which make those descriptions easy to follow.

J. B. S.

NOTES OF A NATURALIST AND ANTIQUARY.

Memories of the Months; being pages from the Note-book of a Field Naturalist and Antiquary, to wit, Sir Herbert Maxwell, Bart., M.P. Crown 8vo. Pp. xii + 300. (London: Edward Arnold, 1897.)

THE competitive exactions of business and social pleasure have their reaction. An increasing number of people are turning with interest to the study of natural history, and are willing to learn from those who can write about it. This is a hopeful sign to those who believe that the social health and physical standard of the nation depend in large measure on affection for country life, and that it would be an evil thing should field and flood cease to afford attractions for active minds. As Sir Herbert Maxwell truly remarks, no head is constructed to carry about an explanation of half the things noticed in the course of a single morning's walk; but if notes are made at the moment of what attracts the eye, be it a landscape, a ruin, a battle-field, a flower, bird, or insect, recourse may be had at home to the information abundantly stored in books, and the significance of what seemed commonplace or trivial becomes evident at once. Without attempting to become a specialist himself, every one has at command the accumulated fruits of the labours of specialists.

Acting upon this conviction, it would appear that Sir Herbert Maxwell has long been in the habit of making wayside notes on a variety of subjects, and from time to time has amplified and published them for the benefit of others.

His method of presenting them to the reader is not very new, as will be perceived by those who are acquainted with the Rev. Robert Willmott's "Summer Time in the Country," Mr. Oswald Crawfurd's "Round the Calendar in Portugal," Prof. Miall's "Round the Year," and other books of a similar nature; and it might, perhaps, have been better to have arranged his miscellaneous and fragmentary notes under zoological, botanical, and antiquarian headings, instead of grouping them, as he has done, under the headings of the months to which more often than not they have no particular relation. This plan would have been more convenient to specialists as affording them the opportunity of at once finding all that relates to their own subject, instead of having to search for scattered notes through three hundred pages.

No one, however, who dips into this little volume will begrudge the time bestowed upon it, for whether he be in search of particular information on a given subject or not, he will perforce linger upon many a page wherein he will find both amusement and instruction.

What more amusing, for example, than the author's account (pp. 259-266), of the attempts made to decipher the inscription on the celebrated Ruthwell Cross, variously interpreted—and by experts too—as Runic

Old Norse, and Anglo-Saxon; or his explanation (p. 184) of the reason for keeping cattle in herds.

For instruction we may turn to such chapters as those on the "Revival of a primitive fauna," on "West coast meteorology," or on "Assisted vision." Some of the pleasantest reading is to be found in the pages which give the results of the author's out-of-door observation. Here, for example, is a note on the enmity between bees and butterflies:—

"All kinds of stonecrop possess peculiar attractions for bees and butterflies owing to their abundant secretion of honey. One of the tall growing kinds, *Sedum spectabile*, is by far the handsomest. It is the latest to flower, and its great, flat, rosy corymbs are irresistible to that splendid autumn butterfly, the Red Admiral. . . . I have been watching a number of these robust insects busy on the large stonecrop—so busy as to allow me to use a lens on them. There were no less than sixteen Admirals at work on one group of *Spectabile* stonecrop. The honey bees, however, interfered with them, and it was curious to see how shrewdly a Red Admiral would sheer off at the approach of a bee of less than one-tenth of his own bulk. . . . Now, how do butterflies learn to dread a bee? How do they know that bees are armed? It can hardly be by experience, for no butterfly could survive the stab of a bee's sting. It is part of the mystery enveloping the intelligence of animals not personally educated by their parents. . . . The phases of insect life—the egg abandoned by the parent, the stages of larva, pupa, and imago—seem specially calculated to interfere with hereditary knowledge, and to prohibit the communication of instruction. . . . This avoidance of bees by butterflies seems to be an instance of pure instinct."

On another page, in the course of some remarks on the choice of food by animals, the author alludes to the fact that some creatures will thrive upon plants which to others are poisonous, and instances the case of the Spurge Hawk Moth (*Deiliphila euphorbiæ*), of which the caterpillar feeds exclusively on the Sea Spurge, although this plant secretes an acrid juice "so painfully poisonous that it is difficult to imagine a digestive apparatus competent to deal with it." He might have mentioned the still more curious case of the caterpillar of another moth, *Deiopeia pulchella*, which feeds on the virulent poison contained in the seed of the Esere or "Ordeal Bean" of Old Calabar (*Physostigma venenosum*), and is unaffected by it (*cf.* Dr. T. R. Fraser, *Ann. Mag. Nat. Hist.*, May 1864).

We should like to know the authority for the statement (p. 141) that in the lines from the "Midsummer Night's Dream" (So doth the woodbine the sweet honeysuckle gently entwist), Woodbine means the Bittersweet or Deadly Nightshade. This interpretation appears to have the sanction of Dr. Prior in his "Popular Names of British Plants," but is opposed to the view of Canon Ellacombe, who has made a special study of the "Plant-lore of Shakespeare."

We have noted other passages on which criticism might be offered did space permit; but enough has perhaps been said to indicate the scope of the volume. While too much in the nature of a scrap-book to entitle it to praise as a literary effort, it has the merit of being distinctly entertaining, and of conveying in a light, pleasant style a variety of information on subjects of more or less interest.

OUR BOOK SHELF.

Notes on Micro-organisms Pathogenic to Man. By Surgeon-Captain B. H. S. Leumann, Indian Medical Service. Pp. 96. (London: Longmans, Green, and Co., 1897.)

THIS compact and well-written little volume does not make any pretensions to be a text-book in the ordinary sense of the word, and we should be sorry if the "students and practitioners" for whom it is intended should in their turn make any pretensions to a knowledge of the subject after its perusal. Indeed, students and practitioners "who have no opportunity of working at the subject themselves, or time to read a larger book," had better remember the old adage, a little learning is a dangerous thing. Bacteriology, unfortunately, suffers at the present time from the idea that it is essentially a popular science—that it is a subject well within the comprehension and well within the grasp of any one who chooses to hold out his hand for it. Thus we too frequently find it taken up by totally unqualified persons, and the results of their recondite researches serve to bring the whole domain of microbes into disrepute. We do not quarrel with Surgeon-Captain Leumann's little book, for it is clearly and concisely written, and makes every endeavour to be accurate and up to date; and of particular interest is the local colouring, if we may use such an expression, which characterises it in dealing with the most recent work in India on plague and cholera. We have no desire to depreciate these notes, but we do regret that the author encourages the practice of reading about bacteria instead of working at them in a class of professional men who ought certainly to be able to do something more substantial than talk about them. Bacteriology to be of any value must be studied in the laboratory; and without a practical acquaintance with micro-organisms, the latest and most exhaustive manual "made in Germany" will fail to do more than acquaint the reader with the superficial phraseology of the subject.

The Winter Meteorology of Egypt and its Influence on Disease. By H. E. Leigh Canney, M.D. (Lond.), &c. Pp. 72. (London: Ballière, Tindall, and Cox, 1897.)

TO people who, for health's sake, pass the winter in Egypt, and to practitioners who wish to know the climatic conditions of the various health resorts of the country, this book will be an invaluable possession. The volume comprises a paper read before the Royal Meteorological Society last December, and one read before the recent International Congress of Medicine at Moscow. The first of these papers contains the results of a series of meteorological observations made under precisely comparable conditions during three or four winters in Egypt. The stations at which observations were made were Cairo, Mena Honse, Helouan, Luxor, Assouan, Valley of the Tomb of the Kings, and the crest of the Libyan Hills. As self-recording thermometers and hair-hygrometers were used at each station, valuable data were obtained on the diurnal variation of temperature and humidity. It appears from the discussion of the observations that the climate of Egypt is influenced by the Libyan or Western Desert, the Mediterranean Sea, and the extent of cultivated land.

The second part of the treatise provides the medical profession with a valuable guide to the therapeutic influences of the climates of different health stations in Egypt. Practitioners who have not been able to visit the country will find this section most serviceable.

Appended to the volume are several clear and instructive diagrams showing, for the six months from November 1895 to April 1896, the temperature and relative humidity at various hours of the day at Helouan, Mena Honse,

Luxor, and Assouan; the drying power of the air at the temperature of the air; and the drying power of the air at the temperature of the body.

Les Fours Électriques et leurs Applications. By Ad. Minet. Pp. 178. (Paris: Gauthier-Villars et Fils; Masson et Cie.).

ALL thermo-electric effects in which electricity is the prime agent are regarded by the author as coming within the scope of the title of this book, the grounds being that all forms of apparatus for converting electrical energy into heat, come under the generic head of *fours électriques*. The book thus includes not only descriptions of electric furnaces in which temperatures approaching four thousand degrees are reached, but also of simple conductors and resistance coils raised a few degrees above the temperature of the atmosphere by the electric current. The first part of the volume is devoted to an account of the heating effects of electricity; it includes descriptions of the heat produced by a current passing through a metallic resistance, the maximum temperatures of conductors, and electric heating generally. The remaining three parts deal with the electric arc and arc-carbons of various forms, electric furnaces and their applications, and carbide of calcium and acetylene.

It will thus be seen that portions of the book are not exactly pertinent to the title, nevertheless they assist the reader to a clear understanding of electro-thermal phenomena. The section on electric furnaces is a concise account of the various forms of furnace devised for different purposes.

The book belongs to the Encyclopédie scientifique des Aide-Mémoire series edited by M. Léauté.

Bibliography of X-Ray Literature and Research (1896-1897); *being a Ready Reference Index to the Literature on the Subject of Röntgen or X-Rays.* Edited by Charles E. S. Phillips. With an Historical Retrospect, and a chapter of "Practical Hints." Pp. xxxvii + 68. (London: *The Electrician* Printing and Publishing Co., Ltd.)

THE work before us gives, in a handy and succinct form, a good deal of information respecting the literature of X-rays. The subject proper of the volume is prefaced by a brief historical retrospect, in which, however, the average worker in physics will find little but what is already known to him, and a short chapter of practical hints intended "to appeal more especially to physical students about to turn their attention to high vacua research." The main and most valuable portion of the book is the bibliography, and this should certainly prove of utility to investigators in this branch of science. The volume, so far as we have been able to test it, appears to have been compiled with great care, and certainly a mass of useful knowledge is here gathered together in a form easy of reference.

Die Meteoriten in Sammlungen und ihre Literatur, nebst einem Versuch den Tauschwert der Meteoriten zu bestimmen. Von Dr. E. A. Wülfing. Pp. xlvi + 460. (Tübingen: Laupp, 1897.)

THE author has sought information relative to the meteorite collections, public and private, from those in charge of them, and has collated and indexed the results in the form of an alphabetical list, giving for each preserved meteorite a statement of the date of fall or find, a list of the more important memoirs relating thereto, and the weights preserved in the various collections. The work has been carefully done, and will be very useful to collectors of these extra-terrestrial bodies. As regards the pecuniary values to be assigned to the meteorites, we are afraid that the dealers will eschew all such mathematical calculations as are suggested by the author, and will in each case get, as heretofore, what they can.

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.*]

Rediscovery of the Tile-fish ("Lopholatilus").

I AM indebted to Dr. John Murray for drawing my attention to an error in the address which I had the honour of delivering before the Linnean Society on May 24. In referring to the discovery and subsequent remarkable disappearance of the Tile-fish (*Lopholatilus chamæleonticeps*), I stated that since the year in which the extraordinary mortality in this species had been observed (1882), "no specimen of the fish has ever been found."

I must take an early opportunity of correcting this error, which I might have easily avoided by reading more carefully the concluding paragraphs of Goode and Beane's account of the Tile-fish in "Oceanic Ichthyology," p. 288, from which I may be allowed to quote as follows:

"In the fall of 1892, Colonel Marshall McDonald, the Commissioner of Fisheries, made another attempt to discover the fish, and was successful, obtaining it from the following stations [five stations are enumerated, on which eight specimens were caught]. The Tile-fish then is restored to the list of existing species of our North Atlantic coast, and it is probable that in time it may attain to its former abundance. The temperature-investigations made by Colonel McDonald have been carefully discussed by him, and he is convinced that the destruction of *Lopholatilus* was due entirely to climatic causes."

What these climatic causes are we learn from a report by Prof. William Libbey, jun., published in the U.S. Fish Commission Report for 1893 (Washington, 1895, 8vo), p. 32; they consist in a variation of the relations of the Gulf Stream to the Labrador current, affecting the temperature of a certain area inhabited by the fish. A lowering of the temperature by the latter current is believed to have caused the sudden mortality, whilst a subsequent invasion of warm Gulf Stream water would allow the fish to gradually reoccupy the depopulated area.

Kew Gardens, November 14. A. GÜNTHER.

The Exploration of the Air by Means of Kites.

THE highest kite ascent, described in NATURE of October 7, was in turn exceeded here by more than 1800 feet on October 15, when excellent meteorological traces (of which a facsimile is enclosed) were brought down from a height of 11,086 feet above Blue Hill. The flight was effected with only four kites, and the ascent and descent occupied but four and a half hours. Excepting a more rapid decrease of temperature with increase of elevation, the results agree with those already stated for the previous high flight.

I now desire to call attention to the fact that the deductions from our automatic records obtained with kites seem to confirm, in general, the conclusions reached by Messrs. Welsh and Glaisher from their observations in free balloons many years ago in England. For example, we find also that the most rapid decrease of temperature with height occurs usually in the lower mile of air during the daytime, and, even with no visible clouds, that damp strata often exist in the dry air of the upper regions. A discussion by Mr. Clayton of more than one hundred meteorological records, obtained with kites since 1894, is now in the press, and will form an appendix to Part i. vol. xlii. of the *Annals of the Astronomical Observatory of Harvard College.*

A curious illustration of how identical methods sometimes may serve diametrically opposed investigations, is the application of the deep-sea sounding apparatus of Sir William Thomson (now Lord Kelvin) to bring *down* these aerial soundings.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, November 1.

Lord Rayleigh's Proof of Van 't Hoff's Osmotic Theorem.

IN what follows I shall understand by "Van 't Hoff's Osmotic Theorem," the statement, that if P, V be the osmotic pressure and volume of unit mass of a solute, and p, v the gas-pressure and volume of the same mass of the same substance supposed gaseous at the same temperature, then $pv = PV$.

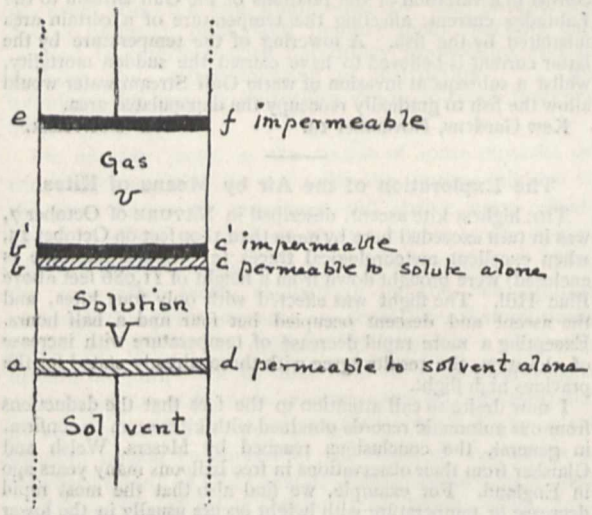
As is well known, this theorem was originally proved by Van 't Hoff by employing a differential thermodynamical process, which led to the result $vdp = VdP$. Assuming Henry's law in the form $\frac{v}{V} = \text{const.}$, and Boyle's law for both gas and solution, *i.e.* $pv = \text{const.}$, and $PV = \text{const.}$, the above result follows at once. Substantially the same proof was given by Nernst in his "Theoretische Chemie."

Quite recently, however, a new and novel proof of the same theorem was published by Lord Rayleigh in the columns of NATURE. In this proof Lord Rayleigh avoids the assumption of the equation $PV = \text{const.}$, and herein lies a definite advance in the subject. The proof is based on the validity of Boyle's law for the gas, and Henry's law; but as the solvent is assumed to be involatile, it was objected by Lord Kelvin that the great majority of cases would thereby be excluded. So far as I can see, a small addition to Lord Rayleigh's proof will suffice to free it from this objection.

Besides this, I think that Lord Rayleigh's proof may be generalised so that even the assumption of Boyle's law for the gas is not required, at all events formally.

The primary assumption to be made is that for isothermal equilibrium the ratio of the concentrations of the substance in question, as gas and as solute, remains constant. This is usually known as the Distribution-Law, and cannot be regarded as a mere deduction from Boyle's law, and a certain form of statement of Henry's law. Recent research rather goes to show that it is a fundamental law of great generality. Accordingly I venture to employ Lord Rayleigh's method of proof, as follows.

ad and *ef* are two pistons, *ef* being impermeable, and *ad* permeable for the solvent alone. *bc* and *b'c'* are two fixed walls, of which *b'c'* is impermeable and *bc* permeable for the solute



only. The piston *ad* is for the present fixed, and encloses a volume V of solvent between itself and *bc*. Suppose the cylinder to have unit section, and denote height of upper piston above the fixed semi-permeable wall by x. The whole process is conducted at the constant temperature t. Suppose now that between *ef* and *b'c'* there is enclosed a quantity of the solute as gas, of volume v, temperature t and pressure p, the amount being so chosen that it is just sufficient to saturate the volume V of solvent at this temperature and pressure. Let ρ denote density of the gas and suppose $p = \rho^2 \phi'(\rho)$ to be the isothermal equation of state for the gas, where ϕ is an undetermined function. Take as unit of mass the mass of the enclosed gas. Allow the upper piston to rise reversibly to a height x, which is a very great multiple of the initial height. The work done in this process is:—

$$\int_v^x p dv = \phi\left(\frac{1}{v}\right) - \phi\left(\frac{1}{x}\right).$$

Let *b'c'* be removed and the gas reversibly compressed, whereby it is reversibly absorbed, the small amount of irreversibility at the beginning becoming vanishingly small in the limit. Denoting by c the concentration of the solution at any moment, we have during the downward stroke:—

$$\rho x + cV = 1$$
$$\frac{c}{\rho} = K \text{ (Distribution-Law).}$$

The work done on the system in this stroke, whereby the gas is just completely absorbed, is given by:—

$$\int_0^x p dv = \Big[\phi(\rho)\Big]_{x=x}^{x=0}$$
$$= \phi\left(\frac{1}{KV}\right) - \phi\left(\frac{1}{x + KV}\right).$$

But $\frac{1}{KV} = \frac{1}{v}$, since by hypothesis $\frac{1}{V}$ and $\frac{1}{v}$ are the concentrations of the substance in solution and as gas respectively, for equilibrium at t and p. Thus the work done so far by the system is:—

$$\phi\left(\frac{1}{x+KV}\right) - \phi\left(\frac{1}{x}\right)$$

where x is indefinitely great.

Separate gas and solvent now, working both pistons so as to keep the concentrations constant, and thus arrive at the initial state, whereby in this portion of the process the system does work $pv - PV$.

Since the net work obtainable in a reversible isothermal cycle is zero, we have finally:—

$$pv - PV + L_{x=\infty}\left[\phi\left(\frac{1}{x+KV}\right) - \phi\left(\frac{1}{x}\right)\right] = 0.$$

Now the term in brackets is zero if $\phi(z)$ has the form $\log z$ or any positive power of z, so that it vanishes if $\phi(z)$ has the form $a \log z + b_0 + b_1 z + b_2 z^2 +$ &c. Hence it vanishes if $\phi'(z)$ has the form $\frac{a}{z} + b_0 + b_1 z + b_2 z^2 +$ &c., since the latter series is by hypothesis convergent.

That is to say, $pv = PV$ if the isothermal equation of state is—

$$p = \rho^2\left(\frac{a}{\rho} + b_0 + b_1\rho + b_2\rho^2 + \text{&c.}\right),$$

or
$$p = a\rho + b_0\rho^2 + b_1\rho^3 + b_2\rho^4 + \ldots$$

This includes the equations of Boyle and Van der Waals as special cases.

The equation $pv = PV$ is thus a formal consequence of the distribution-law and the expressibility of p as an infinite power series of ρ. However, when Boyle's law does not hold, this result loses much of its significance, as it does not then lead to an equation of state for the solution. So that this slight extension of Lord Rayleigh's result is not perhaps of much practical use.

Holywood, Co. Down. F. G. DONNAN.

The Law of Divisibility.

WITH respect to Mr. Burgess's letter in your issue of November 4, perhaps the following general rule for testing the divisibility of a given number by another, which I found some days ago, may be of some interest.

Any number

$$Z = a_n \cdot 10^n + a_{n-1}10^{n-1} + \ldots + a_\nu 10^\nu + \ldots + a_1 \cdot 10 + a_0$$

is divisible by another number N when the sum

$$\sum_{\nu=0}^{\nu=n-a+1} (a_{\nu-a+1} \cdot 10^{a-1} + \ldots + a_\nu)(10^a - N)^{\nu}$$

can be divided by N without residue; otherwise the residue of this division is equal to the residue of the division Z : N.

Of course, from $(10^a - N)^{\nu}$ the nearest multiple of N must be subtracted.

Examples: (1) N = 7. Take $a = 1$; then $10^a - N = 3$, and Z is a multiple of 7 when $a_0 + 3a_1 + 2a_2 - a_3 - 3a_4 - 2a_5 + \ldots$ is divisible by 7.

(2) N = 11. $a = 1\ 10^a - N = -1$; hence Z is a multiple of 11 when $a_0 - a_1 + a_2 - a_3 + a_4 - + \ldots$ is a multiple of this number.

(3) N = 103. If we take $a = 2$, we get $10^a - N = -3$, and Z will be a multiple of 103 when

$$(a_0 + 10a_1) - 3(a_2 + 10a_3) + 9(a_4 + 10a_5) - 27(a_6 + 10a_7) + 81(a_8 + 10a_9) - 37(a_{10} + 10a_{11}) + - \ldots$$

can be divided by 103 without residue.

To take a numerical example, try if 298744898 is a multiple of 103, and determine the residue if it is not.

We get

$98 - 3 \times 48 + 9 \times 74 - 27 \times 98 + 81 \times 2 = -1864$; $19 \times 103 = 1957$; therefore residue $= 1957 - 1864 = 93$,

which will be found correct by performing the division.

I have no doubt the above rule will be well known to mathematicians, but not being much acquainted with the theory of numbers, I cannot at present tell where it may be found; the proof is very easy.

C. BÖRGEN.

Wilhelmshaven, November 7.

THE examples given by Dr. Börgen, in his interesting communication, fall under suggestions (2) and (6) in my second letter, where if $\delta = 7$ the period $\pm$ 1, 3, 2 may be used; or if $\delta = 11$ the period $\pm$ 1 is available; or if $\delta = 103$ take

$$\delta_1 = \delta - a = 103 - 3$$

giving the rule—

Divide N into dual periods beginning from the units place; multiply each by $(-a)^n$, giving to n the successive values 0, 1, 2, 3 &c.; the sum of these positive and negative products is N_1.

I may add, this rule applies to $\delta = 17$, 101, 103, 107, 109, taking $a = -(2, 1, 3, 7, 9)$, or to $\delta = 19$ if $a = 5$, but if $\delta = 83$, N must be divided into triple periods, a being + 4.

HENRY T. BURGESS.

Tarporley, West Norwood, November 11.

HON. RALPH ABERCROMBY.

RALPH ABERCROMBY was born in 1842, and was the youngest son of the third Lord Abercromby. His mother was a daughter of Lord Medwyn, a Lord of Session in Edinburgh. Several of his immediate relatives had been eminently distinguished. His great-grandfather, Sir Ralph Abercromby, who died in 1801, in the moment of victory, at the Battle of Alexandria, had served his country with brilliant distinction, in the West Indies (Trinidad) and at the Helder.

As soon as the news of Sir Ralph's death reached England, and in commemoration of his services, a barony was conferred upon his widow, with remainder to his sons.

Of these sons the second became Sir John. He was in the service of the East India Company, and took the Island of Mauritius in 1810. Another was Speaker of the House of Commons in 1835, and was created Lord Dunfermline.

Ralph was never robust, even as a boy. He went to Harrow, and soon was obliged, owing to delicacy, to leave the school. He had, however, shown signs of great promise by taking a double remove after his first term.

In June 1860 he was gazetted to the 60th Rifles, and four years later obtained his lieutenancy and joined the Fourth Battalion at Quebec.

The War of Secession was then at its height. Abercromby obtained leave and visited the scene of action. He took with him letters to General Grant, and was well received, but he did not happen to be present at any of the great battles.

At the beginning of 1866 he entered the Staff College, having passed in without "cramming," but his health soon broke down there. Two visits to Kreuznach produced no benefit, and in 1869, to his great regret, he felt himself obliged to give up his commission.

In later years he twice was sent on a voyage round the world, in hopes of restoration to health; and it was in the beginning of 1890, at the commencement of a third voyage to the Pacific, that he was taken ill at Sydney—an illness which terminated fatally June 21, 1897. He passed away quietly in his sleep.

Abercromby had, from a very early period, paid much attention to observational meteorology. In his "Seas and Skies in many Latitudes," observations are recorded which he must have made during his military service in Canada. His name will live longest in connection with the new classification of clouds which he, in conjunction with Prof. Hildebrandsson, of Upsala, proposed, and which was adopted by a majority of votes at the International Meteorological Conference of Paris in September 1896.

His published books were: "Principles of Forecasting by means of Weather Charts," 1885, published by authority of the Meteorological Council; "Weather, a Popular Exposition of the Nature of Weather Changes," 1887 (International Scientific Series); "Seas and Skies in many Latitudes," 1888. In addition he brought out many papers which appeared in various journals and periodicals, such as the *Proceedings* of the Royal Society, the *Journals* of the Royal and of the Scottish Meteorological Societies, as well as in NATURE, *Good Words*, &c.

Fifteen papers are down to his name between 1873 and 1884 in the Royal Society Catalogue of Scientific Literature.

From his sick bed in Sydney he showed his great interest in the advancement of the science by making grants of money for the production of essays on meteorological subjects. Three of these have been published: "On Moving Anticyclones in the Southern Hemisphere," "On Southerly Bursters," and "On Types of Australian Weather."

Abercromby retained to the very last the power of making and keeping friends. This was in great measure due to his loyal and affectionate nature, which neither distance nor illness could impair. Those who were with him during his last suffering months bear witness to the patience and gentleness, which were as conspicuous under the trials of severe pain as they had been when he was in full possession of his faculties.

His lot was indeed a hard one. He had first to bear the heavy disappointment of enforced resignation of a profession which he loved, and in which his prospects seemed so brilliant, and then he had to sustain the strain of more than twenty years of impaired and gradually failing health.

He leaves behind him the memory of a warm unselfish friend, cut off in a distant land, far from his kith and kin.

R. H. SCOTT.

REV. SAMUEL HAUGHTON, M.D.

THE announcement of the death of Dr. Haughton has been received with the deepest regret in various scientific circles, and by his numerous personal friends and acquaintance attracted to him by his sturdy honesty, unselfishness, and geniality of disposition. He was born in Carlow in 1821. After a distinguished undergraduate career in Trinity College, Dublin, he was elected Fellow thereof in 1844. He held the Professorship of Geology from 1851 to 1881, in which latter year he was co-opted Senior Fellow of the College. He was admitted F.R.S. in 1858. The Universities of Oxford, Cambridge, and Edinburgh signified their appreciation of his merits by conferring on him the honorary degrees of D.C.L. and LL.D., respectively. Having taken the degree of M.D. in his own University in 1862, he was made Registrar of the Medical School there, and applied himself with his usual energy and activity to the reorganisation of that School; thereby raising it to its present condition of high efficiency. He was elected a Governor of Sir Patrick Dun's Hospital, which is connected with the

University, and there made his presence as beneficially felt in the management of the institution as it was in that of the School. We may take this opportunity of noting that, as the result of his experience in such work, he wrote many papers on medical subjects in various publications, and that the honorary degree of M.D. was conferred upon him by the University of Bologna. He represented the University of Dublin on the General Medical Council, from 1878 to 1896, and took a prominent and useful part in the proceedings of that body. Dr. Haughton displayed remarkable versatility of intellect. The record of his scientific work is to be found principally in his numerous papers in the publications of various scientific societies, and in scientific periodicals. We may instance those of the Royal Society, the Royal Irish Academy, the Geological Society of London (of which he was a Fellow) and that of Ireland, the Royal Dublin Society, the *Cambridge and Dublin Mathematical Journal*, NATURE, the *Philosophical Magazine*, the *Natural History Review*, the *American Journal of Science*, the British Association, &c. Among the great variety of subjects treated we may mention his discussion and calculation of the tides in the Arctic seas from the observations of voyagers, and also of the tides round the coast of Ireland, founded upon observations made under the direction of the Royal Irish Academy. He paid much attention to the granites of Ireland. A favourite subject with him was animal mechanics. It might have been better for his future name, though perhaps not for science in general, if he had bestowed his powers more on the production of *treatises* on fewer subjects. His work on the "Principles of Animal Mechanics" (London, 1873) makes us feel this. That book was the outcome of observations, experiments, and calculation extending over several years. It includes results published in various papers on different parts of the subject, contributed to the Royal Society and the Royal Irish Academy, and in lectures delivered by him before the Royal Institution in London. The important "Principle of Least Action" is brought frequently into view in his discussion of various details of the vertebrate muscular economy. A complaint, which, however, is unavoidable in this case, has been brought against this book; viz. that many anatomists would not be able to follow the mathematics, and many mathematicians would not have sufficient command of the anatomical points, there presented. His "Lectures on Physical Geography," 1880, printed in the Dublin University Press Series, are marked by his usual power and originality. We shall only allude to his "Manual of Geology," and to the numerous books on elementary science written by him and Prof. Galbraith in conjunction, some of which have had a large circulation. Trinity College, Dublin, will long mourn the vacancy left by him as a gifted son, an able administrator, and an active participator in her work of teaching. The Royal Irish Academy will feel his loss to a very special degree. He joined that body in 1845, and contributed to it most of his principal scientific papers. The Academy presented to him its Cunningham Medal, in 1848, for his "Memoir on the Equilibrium and Motion of Solid and Fluid Bodies." He was for many years a most valued member of its Council, and was President of it from 1886 to 1891. We must not forget to mention that he was for just twenty years the efficient Secretary of the Royal Zoological Society of Ireland with its Zoological Gardens, at a time when the finances of the Society were in a less satisfactory condition than at present, and it is acknowledged that, on more than one occasion, he was the means of saving the Society from shipwreck by his energy and resource. It is very rarely indeed that we meet with a man of so remarkable an individuality, and endowed with such varied powers of working in both practical and scientific lines of usefulness. C.

NOTES.

AT a meeting of the general committee of the British Association recently held, Sir W. Crookes, F.R.S., was elected President for 1898. It was decided that the meeting in Bristol shall open on September 7, 1898.

THE Executive Committee of the International Congress of Zoology, which, as has already been announced, will be held at Cambridge in August next, has recently been appointed, and is composed as follows:—President, Sir John Lubbock; Vice-Presidents, the Vice-Chancellor of the University of Cambridge, Dr. W. T. Blanford, Sir W. H. Flower, the President of the Linnean Society, Prof. Ray Lankester, Prof. A. Newton, Dr. P. L. Sclater, the President of the Entomological Society, Sir William Turner, and Lord Walsingham; Treasurers, Prof. S. J. Hickson and Dr. Sclater; Secretaries, Prof. F. Jeffrey Bell, Mr. G. C. Bourne, and Mr. A. Sedgwick; Ordinary Members, Dr. Gadow, Mr. F. D. Godman, Lieut.-Colonel Godwin-Austen, Sir G. F. Hampson, Dr. S. F. Harmer, Prof. Howes, the Hon. W. Rothschild, Mr. H. Saunders, Prof. Seeley, Dr. D. Sharp, Mr. A. E. Shipley, Prof. C. Stewart, and Dr. H. Woodward. The official address of the Congress is, by the courtesy of the Zoological Society, 3 Hanover Square, London, W.

THE interesting ceremony took place on Monday afternoon last, at the Michael Faraday Board School, Faraday Street, Walworth, of unveiling a bust of Michael Faraday. The bust, which is of white marble, was presented to the school by the managers of the Royal Institution of Great Britain, and is a copy of the original bust executed by Matthew Noble. It stands upon a pedestal of Aberdeen granite four feet in height, and has been placed in the boys' hall of the school. On the wall immediately behind the bust a large brass tablet has been affixed, bearing the following inscription:—"Michael Faraday, natural philosopher, D.C.L., F.R.S., born at Newington, Surrey, September 22, 1791. He was a patient student, an eloquent expounder, and a brilliant illustrator of the laws of nature. Fullerian Professor of Chemistry in the Royal Institution of Great Britain, 1833 to 1867. Faraday's noblest monument is his 'Experimental Researches in Electricity and Magnetism' from 1831 to 1851. He died at Hampton Court Green, August 25, 1867, and was interred in Highgate Cemetery." Sir J. Crichton Browne, F.R.S., unveiled the bust, and expressed his pleasure at being permitted to unveil this statue of a great man who had spent a long life in unveiling the hidden mysteries of nature. He hoped the sight of that bust would be an inspiration to the children, and that they would learn who Faraday was and what he did. He suggested that one day every year should be set apart in the school in memory of Faraday, when some part of his work should be explained.

PROF. OLIVER LODGE will deliver the first of a course of six Christmas lectures (specially adapted to young people) on "The Principles of the Electric Telegraph," at the Royal Institution on December 28. The remaining lectures will be given on December 30, 1897, and January 1, 4, 6, 8, 1898.

THE Jubilee Medal has been presented to Sir Robert Ball, the President of the Royal Astronomical Society.

THE Copenhagen correspondent of the *Times* states that an expedition to the Pamir regions will be fitted out next year. Its object will be to make geographical and ethnographical explorations in the northern part of the Wakhan valley. The expedition will be under the leadership of Lieut. Olufsen, and will include two scientific experts. Its cost will be partly borne by the Danish Government out of the Carlsberg fund, and the explorers expect to be absent for two years.

Science announces that the Austrian steamship *Pola* has again gone to the Red Sea for scientific explorations, and will this year cover the ground between Dschedda and Aden. Dr. Franz Steindachner, the ichthyologist, has charge of the zoological work, and observations will also be made in physical oceanography.

THE meeting of the American Psychological Association will be held this year at Cornell University, Ithaca, under the presidency of Prof. Baldwin, the sessions beginning on December 28.

ACCORDING to the Allahabad *Pioneer Mail*, the Ceylon Survey Department is about to start on a cadastral survey of the Crown lands and lands of doubtful ownership in the island, on a scale of ten inches to the mile, and a topographical survey on a scale of one inch to the mile. It is estimated that the cadastral survey will occupy the ordinary staff for about twenty-five years. The triangulation and topographical survey, which will embrace the whole island, will, it is expected, be completed in five or six years. It is stated that at the present time there is no trustworthy map of Ceylon in existence; that there is no contour map of the island of any description, and that the present so-called map is a compilation from Colonel Fraser's map (now nearly 100 years old), and contains errors so numerous and gross as to make it useless. Hence the new surveys to which reference is made.

THE Indian Section of the Pasteur International Memorial Fund has just forwarded a further contribution to the above of 17*l.* 3*s.* 6*d.*, bringing the total amount subscribed in India up to the handsome sum of 460*l.* In a letter to Prof. Percy Frankland, F.R.S., Surgeon Major-General Cleghorn mentions that "the original subscription list contains the names of a goodly number of natives who have subscribed small sums."

WE are glad to notice that Surgeon-Major A. M. Davis is to be attached to the office of the Principal Medical Officer in India, as a tentative measure, for one year, for the purpose of carrying out bacteriological and sanitary investigations. We hope the office of bacteriologist and sanitary investigator will soon be a permanent one. It is also stated that the Madras Government has applied to the supreme Government for the appointment of a bacteriologist, and has received a sympathetic answer, the suggestion of the Government of India being that the present Professor of Hygiene at the Medical College should be appointed Professor of Bacteriology.

FURTHER particulars of the arrangements for the forthcoming meeting of the Australasian Association have reached us. Sir James Hector, the president of the geographical section, has announced as the probable subject of his presidential address—"Submarine Geography," and that the title of his popular lecture will be "Antarctica and the Islands of the Far South." A lecture to working men will be given by Prof. Threlfall and Mr. J. A. Pollock, who will speak on "Electric Signalling without Wires." The following papers, in addition to those already noted in NATURE, have been promised:—"On the Magnetic Force, at Right Angles to the Axis in the Interior of Solenoids," by C. Coleridge Farr; "The Work of High Level Stations in Australasia, with special reference to Mount Kosciusko and Mount Wellington," by Clement L. Wragge; "Milk Analysis in its relation to the Butter and Cheese Industries," by H. W. Potts; "Suggestions for a New Classification of the Eucalyptus," by Prof. Ralph Tate; "On the Occurrence of *Eucalyptus pulveruleata* in Victoria," by A. W. Howitt; "Notes on the Flora of the Mallee Districts of Victoria," by St. Elroy D'Alton; "On the Growth of Galls and Gall Insects," by W. W. Froggatt; "Notes on the Disappearance of Native Races in general, and of Fijians in particular," by H. H. Thiele; "The Colour of Flowers, and its Influence on Bee Life," by Albert Gale; "Notes on the Wax of *Ceroplastes rubens*," and "On the Colouring Matter of *Eris cocci eucalypti*," by E. H. Gurney. A long list of excursions has been prepared, and at a recent meeting of the Council it was unanimously decided that scientific societies in other colonies should be invited to send non-resident delegates to the Sydney session; and that members of the British, American and foreign associations, non-resident in Australasia, who attend, should be admitted free.

THE following science lectures will be delivered at the Imperial Institute on the dates mentioned:—On November 19, "Three Years in the Arctic," by Mr. F. G. Jackson; on November 22, "Electric Balloon Signalling applied to Scientific Exploration in Arctic and Antarctic Expeditions," by Mr. Eric Bruce; on November 29, "The Wild Kafirs of the Hindu Kush," by Sir G. S. Robertson; on December 6, "The Mineral Resources of British Columbia and the Yukon," by Mr. A. J. McMillan; on December 13, "Canada's Metals," by Prof. W. C. Roberts-Austen; on December 20, "The Petroleum Sources of the British Empire," by Mr. Boverton Redwood.

THE International Congress on the Protection of Birds, opened at Aix-en-Provence on November 9, and arranged by the Ligue Ornithophile Française, of which M. Louis-Adrien Levat is the president, was concluded on Saturday last. The protection of insectivorous birds useful to agriculture was the chief matter discussed, and it was decided to forward to the Governments of Europe, through the French Minister of Foreign Affairs, the resolutions which were formulated. Public educational bodies are also to be approached in order to obtain, if possible, the serious consideration of this important subject by schoolmasters and Government school inspectors. Numerous French and Italian agricultural, horticultural, and sporting societies were represented at the Congress, and delegates from the Selborne Society and the Society for the Protection of Birds were also present.

THE late Mr. W. Bolitho of Penzance, for thirty-five years treasurer of the Royal Geological Society of Cornwall, bequeathed 500*l.* to the trustees of that Society, the yearly income accruing from which was to be applied to the purchase of a gold medal, "to be called the William Bolitho Medal, to be awarded to such member of the said Society, whether Ordinary, Honorary, or Associate, whose attainments, labours, and discoveries in Geological or Mineralogical Science shall, in the opinion of the President and Council of the said Society, best deserve recognition." The first award of this medal was made in November, 1896, to Prof. Robert Etheridge, in recognition of "his age, his great attainments, and his life-long labours for the benefit of science." The second award was made on the 9th inst. to Mr. Howard Fox, of Falmouth, in recognition of his various discoveries in the field geology of Cornwall, and of his having brought to light the radiolarian beds of the south-west of England.

THE *Electrical World* (New York) states that the National Museum at Washington has just been enriched by a very valuable and interesting collection, comprising the private papers of the late Mr. Cyrus W. Field relating to the laying of the first Atlantic cable, cable despatches first sent, objects with which Mr. Field worked out the idea of laying the cable, and many other things of interest pertaining to the project. The correspondence and autograph copies of telegrams sent by Mr. Field to the President of the United States and other eminent persons are included. The globe, which was constructed in London, and on which Mr. Field traced the course of the cable

to be laid from Newfoundland to Ireland, forms an attractive object of the collection. It is about 18 inches in diameter, on a stand, with a magnetic compass underneath, and shows many signs of hard usage. The journal kept by Mr. Field and notes of deep-sea soundings set down by him and officers of the *Great Eastern*, which laid the cable, are part of the collection. Mr. Field's private library, with all the literature relating to the work of laying the cable, forms another part. There are also copies of medals presented to Mr. Field by Congress and the French Government, engrossed resolutions passed by public bodies in the United States and in Europe, a cane from the wood of the *Great Eastern*, &c., as well as cases containing sections of the first Atlantic cable.

THE Paris correspondent of the *Times* gives particulars of the trial trip at Mantes of the electric locomotive devised by M. Heilmann. The train, which was composed of twelve carriages and a luggage van, and carried 250 persons, weighed about 150 tons. The object of the trip was not to make a trial of speed, and the train journeyed at the rate of only eighteen miles an hour; the experiment seems, however, to have been considered a great success, and testimony is borne to the ease and regularity of the movement of the train. Great things are hoped from this invention, no less than the conveying of a train weighing 300 tons at the speed of sixty-two miles an hour being looked forward to. The Heilmann engine draws a closed tender containing a steam engine of the Pilon pattern, which works the dynamos producing electricity. The motive power is transmitted directly to the eight wheels, which are only one metre five centimetres in diameter. The consumption of coal by the engine is less than that of an ordinary engine, so that the locomotive can go greater distances with fewer and shorter stops for replenishing coal and water. It will, of course, light up the carriages by electricity, and it is thought that the electric will supersede the air brake.

A LECTURE on "Microscopic Observations on Deterioration by Fatigue in Steel Rails," was given on Monday, the 8th inst., before the Sheffield Society of Engineers and Metallurgists, by Mr. Thomas Andrews, and is reported in the *Sheffield Daily Telegraph*, from which we give a condensed report as follows:—The earlier part of the lecture was occupied with the consideration of the external stress and disintegrating forces imposed on rails, and a large number of illustrations of the state of the wearing faces of rails which had endured the stress of wear for known periods and under known conditions of main line service were given. The gradual development of lines of transverse weakness, indicating the danger from minute cracks, and showing the influences of internal micro flaws in assisting the loss of strength due to vibratory stress were then traced. The effects also of varied chemical compositions on the physical properties and strength of steel rails were also considered, and illustrated by numerous micro-sections and micrographs. The lecturer referred to his recent researches on another serious cause of the loss of strength in rails arising from occasional segregation of the chemical constituents and impurities in steel rails, and offered suggestions for the prevention of this evil. He further referred to the light thrown on this question by recent microscopic researches on the structure of gold and other metallic alloys. The effects of the secondary crystallisation of iron recently observed by the lecturer were also illustrated. Reasoning from the results of his research on the microscopic structure, chemical composition, and physical structure of rails of satisfactory long life, Mr. Andrews indicated the conclusions he had arrived at as to the specification for modern rails best calculated to ensure durability and safety for main line services. The lecturer mentioned that he was still pursuing additional chemical, physical, and microscopical researches on the important question on the loss of strength in steel rails by reason of use, and expressed the hope that valuable results in the interests of the public safety would result.

AT a meeting of the Nottingham Naturalists' Society on November 9, the newly-elected president, the Rev. A. Thornley, delivered a thoughtful address on "The Work of a Natural History Society." In the opinion of the president, the functions of a Society such as theirs should embrace at least the following objects: instruction, stimulation, field-work, and protection. The speaker, in the course of his remarks, regretted that the study of entomology has up to the present been to a large extent neglected in the county of Nottingham, but stated there were signs of improvement in this direction, as during the past year their Coleoptera list had been largely augmented by the labours of several members of their Society.

THE so-called "fruit cure," although not much heard of in this country, is well recognised at various places on the continent, where so-called grape-cure stations have been established. In a recent number of *Modern Medicine and Bacteriological Review* there is an interesting article on the subject, in which the historical side of the question is dealt with. Thus we are told that many medical authorities in the tenth century become enthusiastic in their writings over the remarkable curative virtues of grapes, whilst a certain Van Swieten, of a more modern date, is said to have "recommended in special cases the eating of twenty pounds of strawberries a day." The same gentleman also reports a case of phthisis healed by strawberries, and cites cases in which maniacs have regained their reason by the exclusive use of cherries as food! These instances rather savour of the miraculous; but there is no doubt that the so-called grape-cure, for indigestion and other evils, is carried on in many places on the continent, and that people betake themselves to Meran, Vevey, Bingen, or to Italy and the South of France with the intention of devoting six weeks to the cure, during which time they are expected to have gradually accomplished the feat of consuming from three to eight pounds of grapes daily as the case may be. Grapes are said to exercise a salutary action on the nervous system and to favour the formation of fat, that is to say, when fruit of good quality is employed; if the grapes are not sufficiently ripe, and are watery and sour, the patient may lose rather than gain in weight. Dr. Kellogg, Director of the Sanitarium Hospital and Laboratory of Hygiene at Battle Creek, Mich., is of opinion that the valuable results obtained by a fruit diet in cases of biliousness which he has observed are due to the fact that noxious germs habitually present in the alimentary canal do not thrive in fruit juices.

THE Board of Trade report for 1897 on the sight tests used in the mercantile marine shows that of the fifty-six candidates who failed in colour vision in 1896 twelve were examined on appeal, of whom five passed and seven were rejected. The number of officers already in possession of certificates who, on coming up for examination in 1896, failed to pass the sight tests, was twelve—one master, five mates, and two second mates failing in colour vision, and one mate and three second mates failing in form vision. Two of the mates who failed in colour vision appealed and passed, and one of the second mates who failed in form vision passed on re-examination. The percentage of failures to pass the colour tests was 1·02, a percentage almost exactly the same as that obtained in former years, before the introduction of the wool test. The most extraordinary point in the report is the great number of normal sighted persons who were rejected as colour blind; no less than 41·6 per cent. of those who appealed passed. This state of things, says the *British Medical Journal*, we may expect to continue until properly qualified medical men are employed as examiners, and a trustworthy test is used.

THE Königsberg and Memel district of East Prussia is known to be a district in which ophthalmia is prevalent. According to the *British Medical Journal* a careful examination of the eyes of all children in schools at Königsberg has just been carried out by twenty-seven doctors, the result showing that 32 per cent. of the children are suffering from ophthalmia, and of these more than a third from granular lids.

FROM the U.S. *Monthly Weather Review* for August we learn that the Postal Telegraph Cable Company is co-operating with the United States Time and Weather Service Company of New York in establishing throughout the city a number of handsome clocks which shall exhibit standard time, not only by the face of the clock, but by the dropping of a time-ball at noon. Under the dials are panels, which are filled up partly by special advertisements, and partly by the latest Weather Bureau reports and forecasts, which are thus made known two or three hours before they appear in the afternoon papers. The stands contain, in addition, a barometer and thermometer. The clocks have also been erected in many western cities, and the arrangement is somewhat similar to the so-called Urania Columns in Berlin, where they are said to be very popular.

THE *Indian Daily News* for October 23 contains a preliminary note on the Calcutta earthquake of June 12, by Prof. F. Omori, who has been making investigations on behalf of the Japanese Government. One peculiarity of the earthquake is that, notwithstanding its vast area of disturbance, the motion on the surface was not extremely violent. The variation of the intensity of the shock along lines across the seismic area was very gradual, and from this Prof. Omori infers that the depth of the seismic focus was not less than twenty miles. The shock appears to have been strongest at Shillong, Cheerapoonjee, and the neighbouring district. At Shillong the acceleration was calculated from overturned bodies to be about 8 feet per sec. per sec.; and this, if the period of vibration were one second, would imply a range of motion (or double amplitude) of about 5 inches. Prof. Omori believes that the origin of the earthquake was a sudden splitting asunder of the strata at a great depth, caused by an injection of steam or gas into cracks in the earth's crust. The seismic focus was situated in an east and west direction under the Garo and Khasi Hills, and to the west or north-west of the centre of the great Cachar earthquake of 1869.

A NEW form of electric seismoscope is described by Dr. G. Agamennone in the last *Bollettino* of the Italian Seismological Society, the chief merits claimed for it by its inventor being its comparatively slight cost (about thirty francs) and its great sensitiveness. In most seismoscopes the movement of a pendulum is magnified by a long pointer, whose tip just passes through a hole in a metal plate, contact with which completes an electric circuit and starts a clock previously set at twelve. In the new instrument the metal plate is not, as usual, fixed, but is connected with a second inverted pendulum, the bob of which is near the top of its supporting rod, while that of the first is near the base.

WE have received from the Imperial Observatory of Constantinople the monthly bulletins for January and February of the present year. They contain a brief meteorological summary, and continue, though apparently in less detail, the valuable lists of earthquakes issued for the years 1895 and 1896 by Dr. Agamennone. Both parts are the work of the Director, M. Salik Zéky.

AN automatic controller, intended for checking the issue of tickets in a railway booking-office, has been recently exhibited in London. The machine, which is of Belgian origin, is so arranged that each ticket is printed as issued. By two movements the clerk prints on the ticket the name of the issuing office, the destination of the passenger, the class, number, month, day, and hour of issue, and the serial number of the ticket. At the same time a record of the issue is printed on a slip of paper, which is inaccessible to the issuing clerk, and serves for making up the books at the end of the day, or other convenient opportunity. The names of the stations are arranged round the edge of a disc forming part of the machine, and in issuing a ticket, the clerk sets the name of the station required opposite a fixed mark. A downward movement of a small handle, of which there are a number corresponding to the different classes, causes an electric motor to do the necessary printing and eject the printed ticket from the machine. It is stated that each machine can be made to suit any number of stations up to 100. Where a larger number have to be dealt with, extra machines would be employed. A practical trial of the instrument, is, we understand, to be made on the Northern Railway of France in connection with the suburban service. Where large numbers of stations have to be dealt with, the inventor proposes to modify the arrangement of his machine by fitting it with keys like a typewriter, the depression of any one of which will cause the printing of a ticket for the corresponding station. In this way a possible loss of time in selecting the proper station from the rim of the disc previously referred to will be avoided. The machine, as made for twenty stations, is about 5 feet 8 inches high, and has a base 18 inches square.

THE U.S. Pilot Chart of the North Pacific Ocean for the present month contains, among other useful information, a description of the storm-warning signals employed by the various maritime nations. In looking over this list one is struck by the great success of the system of drum and cone signals introduced in this country in the year 1861 by Admiral FitzRoy, the first chief of the Meteorological Office, as these have been adopted, in either their original or somewhat modified form, in every European country in which storm signals are used except Portugal, which uses flags only; while in France, Germany and the Netherlands the cones or drums are supplemented by the use of flags or balls. They are also used in India and Japan in conjunction with balls, while flags or balls (only) are used in China and in North and South America. Prior to their introduction by Admiral FitzRoy, no signals to give notice of possible atmospherical disturbances were employed except in Holland, where there was a kind of semaphore, showing the difference of barometric readings between two places, from which one's own conclusions could be drawn as to the probability of approaching bad weather.

WITH the notable exception of M. Pénaud, most experimenters on mechanical flight have worked with fixed aeroplanes driven by a screw-propeller. A somewhat new departure has been made by Major R. F. Moore, who has selected the Indian flying-fox (*Pteropus edulis*) as his pattern on which to construct models. From his experiments, which are described in the *Aeronautical Journal*, Major Moore concludes that artificial wings can be constructed in imitation of those of the flying-fox, and that the action of the pectoral muscles can be reproduced by spiral springs of suitable strength to hold the wings expanded, the up and down motion being accomplished by means of a light electric or other motor. Two or more pairs of wings, arranged tandem fashion, are found to be better than a single pair—a result fully in accordance with the conclusions formed by other observers. Major Moore considers it quite possible to construct a machine of this type capable of raising a man.

ONE of the most remarkable papers read at the recent annual meeting of the Botanical Society of America in Toronto was on the discovery of antherozoids in *Zamia*, by Mr. H. J. Webber. The paper has been printed at length in the *Botanical Gazette*, and, after the discovery of a similar mode of fertilisation in *Cycas*

and *Salisburia*, will attract great attention. In *Zamia integrifolia* Mr. Webber states that there are formed, within the pollen-tube, near its basal end, two cells, one in advance of the other. From each of the cells thus formed is developed a motile anthérozoid, two to each pollen-tube. They are of a much larger size than any known in vascular cryptogams, quite visible to the naked eye, and resemble in general structure those of ferns. The mature antherozoid passes into the archegone through an opening at the apex of the pollen-tube, and the fluid in which it swims about is supplied by the watery contents of the pollen-tube. The nucleus of the antherozoid is very large, and is surrounded on all sides by a thin layer of cytoplasm. The antherozoids rotate, the cilia continuing to oscillate for a considerable period after the rotation has ceased.

THE *American Naturalist* for October contains a short memoir and a photograph of Mr. J. E. Humphrey, the botanist, whose untimely death from malarial fever while on a scientific expedition to Jamaica we recently recorded. Born in 1861, at Weymouth, Mass., he took up the study of botany from his student-days. Immediately after graduation he was appointed assistant in the botanical laboratory at Harvard, under Prof. Goodale. In 1887 he was selected as instructor in botany in the University of Indiana, and in 1888 botanist to the State Agricultural Experiment Station at Amherst, Mass. From 1892 to 1894 he studied under Prof. Strasburger at Bonn, and on his return was appointed lecturer on botany to the Johns Hopkins University at Baltimore. His best-known work was in connection with the diseases caused in plants by parasitic fungi.

A MONUMENT to the great anatomist Malpighi was unveiled on September 8, in his native town of Crevalcore.

THE last number of the *Proceedings* of the Zoological Society includes two papers which form important additions to the knowledge of the land fauna of Spitsbergen. The collections described were formed during Sir Martin Conway's expedition by Dr. J. W. Gregory. The first paper is by Mr. D. J. Scourfield, and describes the Rhizopoda, Tardigrada and Entomostraca The Rhizopoda include twenty-one species, all of which have a wide distribution in space, but are all new to the Spitsbergen fauna. In several species, especially *Euglypha ciliata* and *Nebela collaris*, the shells are abnormal in shape, which Mr. Scourfield suggests may be due to the severity of the climate under which they live, for the specimens of *Cyclops* collected are also abnormal. Among the Tardigrada four species are described, of which one, *Echiniscus spitsbergensis*, is new. Only one Water-bear has been previously recorded from Spitsbergen; it was described by Goes in 1862 as an ally of *Macrobiotus dujardini*. Two species of Acarina are recorded, both additions to the Spitsbergen fauna, as are also the two species of Copepoda.

A SECOND paper, by Mr. David Bryce, deals with the Rotifera Previously the only records of members of this group from Spitsbergen were the mention of two indeterminable species by Goes in 1862, and the identification of one species (*Callidina alpium*) by Ehrenberg in 1869. Mr. Bryce's paper adds twenty-five more species belonging to ten genera. Two of the species (*Stephanops tenellus* and *Callidina venusta*) are new. The commonest species collected was *Callidina plicata*. The previously known species are North European in range: some of them are very rare; one *Callidina cornigera* has been previously known only by two single specimens. Bergendal has recorded eighty-two species of Rotifera from Greenland, but from a latitude about 700 miles further south than the Spitsbergen specimens were collected; and of the Greenland species only three were collected in Spitsbergen.

THE number of investigations in physiology and the allied sciences now made in the United States of America having become so numerous, it has been thought that the present means of publication need supplementing; hence it has been decided to start in January next a special journal, entitled *The American Journal of Physiology*, to meet the needs of investigators in physiology, physiological chemistry, physiological pharmacology, and certain other branches of biology. Each volume, which will be edited for the American Physiological Society by an influential board of seven doctors, will contain about five hundred pages, divided into parts or numbers, to be issued whenever enough material has been received. The promoters are not very sanguine as to the financial success of their enterprise—at any rate, for some time to come; and they, therefore, solicit the aid of all friends of learning until the journal shall be established on a self-supporting basis. The yearly subscription price for the British Isles is a guinea, and subscriptions should be sent to Dr. W. T. Porter, 688 Boylston Street, Boston, Mass., U.S.A.

WE offer our congratulations to our contemporary the *Electrical Review*, which, with its current issue, completes the twenty-fifth year of its existence. This event is celebrated in a fitting manner by the publication of a number of articles by specialists dealing with the progress made in the various departments of physical science during the time the *Electrical Review* has been in circulation. Our space is too limited to enumerate even the titles of the special contributions to this number; it must suffice for us to say that a vast amount of information is given in a very condensed form, the perusal of which is certain to interest all physicists.

DR. DONALD MACALISTER, of Cambridge, has, with the assistance of Prof. Cattell, of the University of Pennsylvania, just completed a thorough revision of the second part (Sections ix.-xv.) of his English translation of Ziegler's "Text-book of Special Pathological Anatomy." This announcement will be welcome to many students of the subject, as the book has been inaccessible for some time past. The new part will be published in the course of a few weeks by Messrs. Macmillan and Co., Ltd.

WE have received from Messrs. George Newnes, Ltd., the first part of the serial issue of Nansen's "Farthest North," which is being brought out in this popular form by arrangement with the original publishers of the work. The book will be completed in twenty fortnightly parts.—From the same publishers also comes the November number of the *Strand Magazine*, which, as usual, contains one or two articles treating of science in a popular manner. In the number before us Mr. Grant Allen writes pleasantly on "Marriage among the Clovers," and certain "Pests" are written about by Mr. Warren Cooper. Two of the pests in question, viz. "The Jack Rabbits of the United States," and "The Water Hyacinth of the St. John's River, Florida," have already received notice in the columns of NATURE (vol. liii. p. 586, and vol. lvi. p. 332).

THE additions to the Zoological Society's Gardens during the past week include a Whooper Swan (*Cygnus musicus*), a Night Heron (*Nycticorax griseus*), European, presented by Mr. W. H. St. Quintin; a Californian Quail (*Callipepla californica*) from California, presented by Mr. Walter Robertson; a Gannet (*Sula bassana*), British, presented by the Rev. G. H. Thompson; a Dwarf Chameleon (*Chamæleon pumilus*) from South Africa, presented by Mrs. Wolterbuk; a Common Seal (*Phoca vitulina*), British, deposited; a Rosy-billed Duck (*Metopiana peposaca*), three Anomalous Snakes (*Rhadinæa anomala*) from South America,, two Golden Plovers (*Charadrius pluvialis*), two Dunlins (*Tringa alpina*), four Common Gulls (*Larus canus*), British, purchased; three Himalayan Monauls (*Lophophorus impeyanus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NOVEMBER METEORS (LEONIDS).—Although it was known that the presence of the moon would hinder materially the brilliancy of the display of the members of this particular meteor swarm, many hoped that the weather at least would compensate us for that of last year. We were, however, doomed to disappointment, and clouds were the order of the night, both in London and in many other counties where observers were on the watch. Mr. Denning, writing from Bristol on the 15th, observes lamentably, ". . . up to the present time my results are negative. November 12 was cloudy all night, November 13 cloudy, except for an interval of partly clear sky between 11h. 30m. and 14h., and November 14 overcast all night."

Saturday night (November 13) in London proved really a first-class night for such observations, excepting, of course, the presence of the moon. It is true that white fleecy clouds occasionally came rolling up from the southward, but they afforded a magnificent spectacle, and soon disappeared in the north, leaving the sky brilliantly clear. Three facts were impressed on one when watching the heavens: first, the dearth of meteors; second, the great number of stars visible considering the brightness of the moon; and third, the extreme mildness and absence of dew.

In a watch lasting more or less continuously from 9h. to 17h. o'clock, only twenty meteors were seen, fourteen of these being estimated as Leonids, three Andromedes, and two Lyrids.

The five most brilliant Leonids were plotted directly on a star chart (Mean Equinox 1870). Three of these, when their trails were prolonged backwards, converged nearly to a point giving the coordinates of the radiant point as 152°, + 25°, while the other two apparently emanated from 171°, + 19°. The details of each are as follows:—

No.	G.M. Time	Coords. of commencement		Coords. of end		Colour	Remarks
	h. m.	°	°	°	°		
1	13 50	177	+ 4	187	− 18	Yellowish	Very quick
2	14 10	184	+26	197	+33·4	—	,,
3	14 50	143·4	+22	123·4	+ 13	Yellow-blue	,,
4	15 30	156	+35	161	+ 45	—	,,
5	15 55	166	+11	182	− 8·9	Reddish tinge	Very slow, nucleus, very wavy trail near head just before disappearance

Number 5 was somewhat unusual, falling towards the south-eastern horizon very slowly, that part of the trail close to the head being distinctly wavy. It may be mentioned that two cameras pointed first towards the Pleiades in the earlier portion of the evening, and towards Leo when sufficiently high in the sky, recorded not a single trail, although fourteen plates were exposed for forty minutes each during the time of observation.

JUPITER'S THIRD AND FOURTH SATELLITES.—Prof. Barnard has communicated to the *Astr. Nach.* (No. 3453) some most interesting observations of the third and fourth satellites of Jupiter, together with a set of drawings of these bodies made both out of and at the time of transit. These observations are valuable, as they can be compared with those made by Mr. Douglass, and described in the *Astr. Nach.* (No. 3432). That they differ from these latter is only natural considering the difficulty of the observations themselves, but that this difference is so great and fundamental is very surprising. Mr. Douglass, it will be remembered, found that the surfaces of these two satellites were covered with series of fine dark lines, measuring less than 0″·1, or about 200 miles, and similar somewhat to those surface markings as observed at his observatory upon Mars, Venus, and Mercury. Prof. Barnard, on the other hand, has failed altogether to see these details, although he has employed the 36-inch Lick refractor in the attempt; the markings he observed always appeared to be large and more or less diffused, with the exception of the white polar caps which, as he says, are exactly like those of Mars. In the case of the third satellite the cap is generally situated at the north limb, although on one or two occasions a white southern cap has been observed. Both caps of the fourth satellite have been clearly distinguished, that at the north being sometimes exceptionally large, covering a surface equal to one-quarter to one-third of the diameter of the satellite.

Most interesting are the appearances and apparent changes of form which these satellites undergo when in transit. Thus, as regards the third satellite the transit "was very remarkable. The satellite appeared as a black or very dark spot on its disc, and close to the south limb of the satellite was a small, round, very white spot, fully as conspicuous as I have shown it. No other details were seen on it." The drawing referred to above shows the satellite's disc very nearly black, the spot measuring about one-sixth of the diameter of the satellite being represented nearly white. The observations of Prof. Barnard show fairly conclusively that the changes in form of the discs as they pass across the primary are only apparent, and not due to any peculiarity of shape of the satellites themselves. In fact, he himself is perfectly convinced that they are caused by the relative intensities of the satellite's markings in their transit over those of the primary. The peculiar feature of a double dark spot, or an elongated white spot shown by the first satellite in transit, is due to the fact that this body has a bright equatorial region and dark poles. When transiting across a bright portion of Jupiter's disc, the satellite appears like a double dark spot, and when over a dark portion like an elongated white one.

The discrepancy between the forms of the surface markings on these satellites, as seen by two such observers as Mr. Douglass and Prof. Barnard, is indeed remarkable, and it would be of interest to know what would be the result of an interchange of instruments at the time of the next oppositions.

COMET PERRINE (OCTOBER 16).—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week as computed by Herr. J. Möller (*Astr. Nachr.*, No. 3456):—

12*h*. *Berlin M.T.*

1897.	R.A.	Decl.	log *r*.	log Δ.	Br.
	h. m. s.	° ′			
Nov. 18	18 28 14	+64 43·0	0·1436	9·9896	0·9
19	26 1	63 53·0			
20	24 3	63 4·6	0·1418	9·9993	0·8
21	22 18	62 17·7			
22	20 43	61 32·3	0·1403	9·0089	0·8
23	19 17	60 48·3			
24	17 59	60 5·7	0·1388	0·0184	0·8
25	16 49	59 24·6			
26	18 15 45	+58 44·8	0·1376	0·0278	0·7

THE VARIABLE STAR β LYRÆ.—If Argelander's formula be used for the determination of the times of minima and maxima of this variable star, it will be found that these times do not exactly correspond with those now observed. Herr Pannekoek has recently undertaken to investigate the cause of this discrepancy, and has published his results in the *Koninklyke Akademie van Wetenschappen te Amsterdam* (vol. v. No. 7). A brief account of the main results are, however, contributed to the *Astronomische Nachrichten* (No. 3546). The improved formula for determining the times of the principal minima is given by Herr Pannekoek as

$$1855\ \text{Jan. } 6,\ 604\ \text{Greenwich M.T.} + 12{\cdot}908009\ E + 0{\cdot}000003855\ E^2 - 0{\cdot}000000000047\ E^3,$$

and he adds a table, which facilitates greatly this computation, containing every twentieth minimum from E = − 500 (1837) to E = + 1500 (1908).

To determine the amount, if any, of a variation in the light curve, Herr Pannekoek divided the period of observation into two parts, before and after 1870, and obtained two sets of mean values for the mantissæ of the principal points reckoned from a principal minimum:

	1st max.	2nd min.	2nd max.
	d.	d.	d.
1842-1870	3·12	6·40	9·54
1870-1895	3·32	6·48	9·73

This showed that the difference between the intervals from the principal minimum in the case of the maxima was quite apparent, while in the case of the secondary minimum it was comparatively small. It is pointed out, however, that a possible cause may be due to different methods of curve-drawing, some observers drawing the curves symmetrically, and others not. The curves, he finds, further show small irregularities in intensity somewhat of the same kind as those observed in η Aquilæ, which render uncertain the times of first maximum and principal minimum. Herr Pannekoek finds that only the variation in the time of the maxima can be put down to causes other than those of errors of observation and drawing.

GEOLOGISTS IN CANADA.

IN recording in our columns the proceedings of the British Association at Toronto last August, passing reference was made to the excursion to the Pacific coast which was to take place at the close of the meeting. This excursion was in every way such an unqualified success, and especially from the point of view of the geologist, that we think some further account will be acceptable to British geologists who were unable to attend the meeting.

It was indeed a tour which could not but make a lasting impression upon all of us who took part in it. The vast extent and diversity of the country traversed; the richness of the material resources of the Dominion of Canada; the energy and enterprise of its inhabitants; the orderly conditions of the new civilisation even in the remotest settlements, were features which could only be properly appreciated after an experience of this kind. And beyond these general impressions it was scarcely possible for the student of any branch of science to traverse the great continent without accumulating fresh material and fresh ideas in his own particular subject. Amid a panorama of scenery always interesting and sometimes magnificent, we were carried from ocean to ocean in the greatest comfort, in many parts of the course through stretches of mountain and forest which but for the railway would have been absolutely impenetrable for the traveller however well equipped.

The arrangements for the excursion were made by the Local Committee in Toronto, who invited a limited number of the visiting members of the British Association to take part in it. To these members the Canadian Pacific Railway Company munificently presented tickets for the whole length of their main line, with the privilege also to travel without cost over any of their branch lines. A special car was attached to each of the west-bound trains leaving Toronto on three consecutive days, and remained at the service of the members until they reached the Pacific coast. The excursion party thus resolved itself into three groups, which were so arranged by the Local Committee that those of like interests should as far as possible travel together.

The geologists and their friends the geographers formed the third of these groups, leaving Toronto in the sleeping car "Chaudière" on the noon of Friday, August 27. They were especially fortunate in having for their leaders Dr. G. M. Dawson, the Director of the Canadian Survey, and Prof. A. P. Coleman, of the Toronto University and the Bureau of Mines of Ontario, men whose knowledge of the country to be traversed was so intimate that no point of interest could escape unnoticed. Among the members of our party were Dr. W. T. Blanford, Prof. W. C. Roberts-Austen, Dr. C. Le Neve Foster, Prof. Albrecht Penck (of Vienna), Prof. W. M. Davis (of Harvard), Prof. K. Huerthle (of Breslau), Sir George Robertson, Prince Kropotkin, Prof. H. E. Armstrong, Colonel F. Bailey, Prof. T. Hudson Beare, Dr. H. O. Forbes, Mr. W. E. Hoyle, Dr. A. Harden, Dr. J. Scott Keltie, Mr. G. W. Lamplugh, Dr. H. R. Mill, and Prof. H. A. Miers.

From the very outset the geological interest of the journey was continuous. Scarcely had we left Toronto when Prof. Coleman pointed out to us the long stretches of the Iroquois beach, an ancient tilted shore-line of Lake Ontario. Next we passed for three or four hours over an irregular plain of drift, beneath which lay hidden the almost undisturbed Palæozoic rocks of this region. After skirting the shores of Lake Simcoe, we crossed the great unconformity, and found ourselves upon that vast Archæan protaxis which was thenceforward to be traversed for a distance of over 1100 miles almost without interruption. Night closed on the characteristic scenery of this Archæan country—a timbered wilderness with hummocky rocks, everywhere smoothed and polished by glaciation, rising into low hills and enclosing lakes and lakelets innumerable with swamps or sluggish drainage channels between. Lake Nipissing, with its ancient terraces, through which it is believed that the outflow of the Upper Great Lakes once found its way into the Ottawa River, was passed in the night. In the morning we found ourselves "side-tracked" at Sudbury, in the centre of a mining region, which already produces fully one-half of the world's consumption of nickel, and could supply more.

With that energetic hospitality which met us at every halt, the Mayor of Sudbury, with a local committee of reception, was early astir with a carefully arranged plan for the day. After a public breakfast a special engine was at hand to take the "Chaudière" and its occupants to the renowned Copper Cliff Mines. Through the admirable forethought of Dr. Dawson, who struck something akin to awe into us by his power of conjuring up in the most unlikely places whoever or whatever we might most desire, Mr. A. E. Barlow, of the Canadian Survey, had made his appearance on the train during the night from his camp in the woods, and was ready to give us the benefit of his intimate knowledge of the district. With him and Prof. Coleman as our guides, we studied to the best advantage at the outcrop, the mode of occurrence of these great deposits of nickeliferous pyrrhotite and chalcopyrite which apparently are segregated in an area of gabbro near its contact with granite. We were then shown through the surface works of the mine, the managers pointing out to us each stage in the reduction of the ore, from its initial crushing and roasting to its smelting into "matte," in which form it is sent east for further refinement. Some of these processes were especially interesting to the metallurgists and chemists of our party.

On leaving this mine we divided into two companies, those who were anxious to see more of the nickel-mines visiting Denison, about twenty miles west of Sudbury, where the prospectors were developing an ore-deposit similar in character to that of Sudbury, but remarkable as containing also some platinum in the form of the rare arsenide, sperrylite, and a little gold. Here some of the earth overlying the ore-deposit was panned out, and a fair show of grains of sperrylite obtained.

The other members were conveyed by their special engine to Fairbank, a few miles distant, whence they went in wagons over a terribly rough "corduroy" road to a place in the woods where a curious vein of carbonaceous material had been struck, which its discoverers hoped might prove a valuable source of fuel. This material, known as anthraxolite, though not a true coal in the ordinary sense, is composed of almost pure carbon. It occurs in this place as an irregular upright vein, in some parts several feet in width, somewhat interpenetrated by quartz. This vein cuts across the bedding of the surrounding dark carbonaceous slaty rocks, which are either of Lower Cambrian or of Huronian age.

At this place, as we wound our way along the forest trail towards the luncheon place, there was a sudden and for the moment inexplicable stampede of the foremost members of the file, who had unwittingly plunged into a hornet's nest, and suffered inconvenience in consequence. And this little accident was the only mishap of the whole journey!

After luncheon a further expedition was made in birch-bark canoes up the Vermilion River, for three or four miles, to a spot on Vermilion Lake where a shaft had been sunk to develop another vein of the anthraxolite, but where its mode of occurrence was not so clearly seen. On regaining our vehicles, we were conscious on starting of a sense of loss, and then perceived that our two most prominent foreign members were missing. We discovered them, however, placidly eating pie in the log-cabin of a settler. They eagerly explained that they were "studying the customs of the country"—a phrase which thenceforward acquired a special significance.

In returning to Sudbury our train was stopped to allow Mr. Barlow to point out an intrusive contact of the Laurentian granite upon the brecciated edge of the diorite (Huronian?), which appears to be the normal relation of the two rocks in this region. This makes it somewhat difficult to understand how the metalliferous ore has been concentrated at the original margin of the basic mass.

In the evening we were banqueted by the citizens, and after many mutually complimentary speeches retired to the "Chaudière" with the consciousness of a well-spent day.

The morning of the 29th found us traversing a sparsely inhabited region of lakes and forests to the north-east of Lake Superior. The rocks were for the greater part of Laurentian type, a matted complex of igneous intrusions mostly of granitic character, but presenting now and again a more basic "Huronian" aspect. The marks of glaciation were everywhere visible, on a scale quite inconceivable to the British glacialist—in fact, one might say that this whole day's journey was across a huge glaciated surface.

And here it may be remarked, as illustrating the immense scale of the glacial phenomena of North America, that throughout the whole of our journey of 3000 miles we were never at any one point outside the limits of the glacial deposits, and that in one shape or another the evidences of former glaciation were always visible from our car windows. Moreover, we might have gone eastward from Montreal for an additional 750 miles,

to the shores of the open Atlantic, with still the same glacial surroundings!

In the early afternoon at Heron Bay, Lake Superior lay below us, and until nightfall our course ran through the bold and picturesque scenery of its cliffy margin. Old beach-terraces lying high above the present lake were pointed out to us in many places, these being the margins of different stages of the ancient glacier-dammed lake of vast extent to which the names Warren, Nipissing, &c., have been applied.

Towards evening there came a change in the profile of the land, striking alike to the geologists and the geographers, the familiar low hummocky outlines of the Archæan giving place to the bolder features of broad tabular rock-masses rising high above the lake with cliff-like sides, the bright red tints of which were strongly accentuated by the setting sun. These masses are composed of Lower Cambrian rocks (Animikie and Keweenawan), chiefly red sandstones and shales with some thin limestones, preserved under a capping of columnar diabase, which rest with the most pronounced unconformability, cake-like, upon the irregular Archæan floor, like the Torridon Sandstone on the gneiss in the North-west Highlands.

As if the elements themselves were imbued with the spirit of Canadian hospitality, not only was the weather almost throughout our tour everything one could desire, but also on this particular evening there came a fine display of aurora borealis to charm us when darkness had hidden the land.

The following day, August 30, we arrived early at Rat Portage, the chief mining centre of Western Ontario, where we found Mr. McInnes, of the Canadian Survey, just in from his camp to meet us. Here again we were received by the principal citizens, and led at once to the wharf on the beautiful Lake of the Woods, where a special steamboat had been chartered for us. The extremely interesting Archæan geology of this region has been made known to European geologists by the classic Canadian Survey Memoir of Prof. A. C. Lawson, and we rejoiced in the opportunity to examine some of the sections described by him. Our first object was to visit the highly successful Sultana gold mine on an eastern arm of the lake. On the way thither we stopped to land at one of the Indian Reservations, where a curious native burial-ground had attracted our attention; and the pathetic mementos which decorated a child's grave excited our somewhat too obtrusive interest. Later in the day we were enabled to visit a second camp, and see something of its living inhabitants.

At the Sultana Mine, where a mill of ten stamps is already at work and a number of additional stamps are being erected, we were shown the process of treating the ore, which is largely free-milling, only 20 per cent. of the gold being left in the concentrates for recovery by the chlorination process. The metal occurs in a quartz vein, at one place admirably exposed at the surface, which traverses the country-rock near the contact of granite, said to be Laurentian, with Huronian diabase. Throughout the Dominion it appears to be in similar positions around the contact of intrusive masses that the chief metalliferous deposits are found.

Led by Prof. Coleman, to whom this whole region is familiar, and by Mr. McInnes, we next ascended the hill to the east of the mine, and further examined the junction of the so-called Laurentian granite with the Huronian rocks, and noted the intrusive character of the former. Then rejoining our steamer we went westward to some islands in the lake, on which the agglomeratic and apparently volcanic character of the Huronian rocks was well displayed.

The waters of the lake were thick with a minute green floating organism, probably an alga. It is said that there are 13,000 islands in this lake alone; which may be an over-estimate, but they are certainly very numerous. We were told that they were to be bought at all prices, from five dollars upwards, so that the possession of a private island in this part of the world need not be an expensive luxury. And it might, perchance, hold a gold-mine!

Spending the night at Rat Portage the geologists were early astir next morning, and found time for further investigation of this interesting locality. Under Prof. Coleman's guidance we studied the contact of Laurentian and Huronian at several points to the westward of the town, near where the waters of the lake pour through three distinct outlets to form the Winnipeg River. It can scarcely be said that our investigations enabled us to grasp the complex relationship of these great rock-groups, though in some of the sections the gneissic Laurentian seemed clearly to be intrusive upon the Huronian. But the general impression to be gathered from all we saw of these rocks was that the term Huronian might include very different rocks in different places, and that still more was this the case with the term Laurentian. Until the Post-Archæan rocks are reached no strict divisional lines seem possible. Upon such difficult problems as these of the oldest rocks, however, the casual observer of a few isolated sections has really no right to own an opinion.

The enormous water-power which the Lake of the Woods contains, has to a slight extent already been utilised at one or the other outlet, in the production of an electric supply for the city, and for driving extensive flour-mills at Keewatin. But a fine dam is now nearly finished by which the whole outflow will be made available for industrial purposes, and it has even been proposed to convey the power to Winnipeg over 100 miles distant. The navigation of the lake between Rat Portage and Keewatin had lately been much impeded by a floating island of vegetation, but this, as we saw, had been surrounded with a boom of logs, and fixed to the shore.

Boarding the train again at Keewatin, our course lay for a few hours longer through typical Archæan country; but gradually the old rocks sank beneath the drift-plain, and before reaching Winnipeg in the afternoon we had passed once more on to a hidden platform of the Older Palæozoics, and had reached the edge of the great prairies. We were now within the basin of the glacial Lake Agassiz. This extinct lake is believed by its explorer, Mr. Warren Upham, to have extended eastward well beyond the Lake of the Woods, and westward to the "second prairie steppe" of Dr. Dawson, a breadth of about 250 miles, while the length from its termination southward in Minnesota to its northern shore against the ice-sheet north of the present Lake Winnipeg may have been nearly 700 miles; its area has been given as about 110,000 square miles, or greater than the total of the six existing great lakes, Superior, Michigan, Huron, Erie, Ontario and Winnipeg! It is to its finer sediments that the wonderfully productive character of the soil of the Manitoba prairies is largely due.

At Winnipeg, the "half-way house" of the continent, the west-bound trains stop for an hour and a half to refit. With special tram-cars at our service, we were thus able to see something of this substantial city with its many handsome buildings. The old Hudson Bay post, Fort Garry, standing in their midst, reminded us how marvellously rapid has been the growth of this western capital.

On the evening of August 31, with Winnipeg behind us, the crossing of the plains had fairly commenced. Some writer—it must surely be Lawrence Sterne—has pointed out the great value of a plain to the discursive recorder of travels. One could not do better than follow this preceptor by setting down here some general reflections which might otherwise find no place for themselves.

First, we have to regret how few in number were the British geologists to avail themselves of this magnificent opportunity for study. It is often urged against us, and not without reason, that we are too insular in our ideas and too apt to ignore the work done beyond our borders. Certainly the geologist who confines his attention solely to the neat details of British stratigraphy can scarcely hope to realise the true proportions of the problems with which the earth-student must deal. Explanations of phenomena which seem quite applicable on the small scale, often reveal their essential inadequacy under wider conditions of application. And for a corrective study of broad conditions this transcontinental journey must assuredly be unrivalled.

The railway goes more or less at right angles to the strike of the continent, and traverses therefore all the main rock-masses of which the land is built, and all the great structural features by which it is diversified. Hence the final impression which the geologist receives is that of some vast diagrammatic section of a continent. Even the scant time spent in making the traverse was, on this occasion, compensated for by the presence of the men who knew all that is yet known of the route, and who were always ready to impart what they knew.

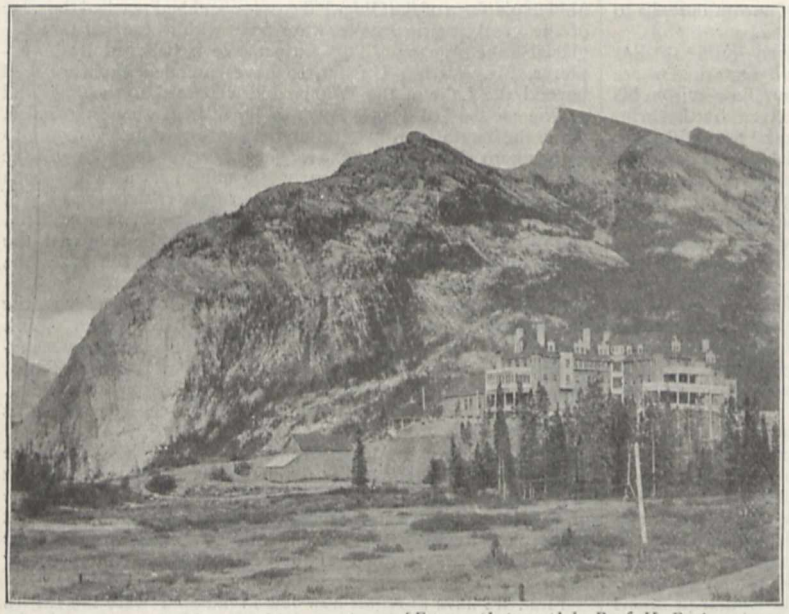
Next, although in the abstract patriotism is out of place in science, let us record the sense of gratification felt by the British members of the party, that across the breadth of this wide and prosperous Dominion we were among brothers. One could scarcely make a journey of this kind without becoming a little more Imperialist than before.

Then let us set down our admiration for the work of the

Canadian Geological Survey. Considering the means at its command, and the positively inconvenient extent of its territory, it is marvellous how much has already been accomplished, and how clearly the general structure of the country has been brought out. It was pleasant to observe, too, how well its work was appreciated among the people for whom it was primarily intended, and how in the mining districts the geological maps we carried were quite familiar to the prospectors and mining people generally, who were usually themselves furnished with copies.

And now for the Plains! They were a knotty problem for our geo-morphologists, not easily to be solved by "base-levelling" or other familiar methods, and we crossed them without properly understanding them. Considering their elevation, it is clear that they should not remain so flat!

But, taking them as we found them, we passed during the night from the first or Red River Plain to the second steppe, where there are some undulations, and before noon had crossed this also, and had reached that remarkable feature the long ridge-like Missouri Côteau, which is largely made up of glacial detritus, and is probably morainal in origin. We then reached the third steppe, which has an elevation of a little over 2000 feet above sea-level at its eastern edge,



[*From a photograph by Prof. H. E. Armstrong.*

FIG. 1.—The western or dip-slope of Mount Rundle (9635 feet); a faulted and tilted mountain-block, chiefly of Devono-Carboniferous Limestones. From Banff Hot Springs.

but rises gradually to over 4000 feet at the foot of the Rocky Mountains. These plains are all underlain by Laramie and Cretaceous rocks lying flat and undisturbed, containing seams of lignite, and in places yielding natural gas. There were few sections, however, either natural or artificial, excepting in the superficial drift deposits. In these drifts boulders of Laurentian rock are very numerous, many hundreds of miles from their source. The third steppe is almost entirely a cattle-ranching country, with a dry climate, as is indicated by the numerous salt lakes visible from the railway. In crossing it, the Cypress Hills, an outlier of Miocene rocks, broke the horizon to the southward, and the surface generally became more diversified than in the lower steppes.

At Medicine Hat, in the evening, we crossed the South Saskatchewan, and under ordinary circumstances should have entered the Rocky Mountains during the night. But our director determined that we must make the approach by daylight, and gave orders that our car should be detached in the night at Calgary, where at daybreak the long range of mountain peaks was just in view. A special engine had been conjured from somewhere, and stood ready to take us forward to Banff. By this arrangement, what was for the geologist the most impressive part of the route was seen to full advantage.

As we approached the mountains we saw how the Laramie and Cretaceous rocks gradually lost their horizontality, becoming more and more tilted and crumpled as the foot-hills were traversed, until—at the entrance to the mountains—the disturbances suddenly culminated in a magnificent overthrust, as clearly visible on the bare mountain-wall as in a text-book diagram. By this thrust the Cambrian, Devonian, and Devono-Carboniferous limestones have been driven eastward over the broken Cretaceous strata for a horizontal distance estimated by Mr R. G. McConnell at seven miles, with a vertical displacement of 15,000 feet.

We stopped just long enough at Kananaskis to gain a clear impression of this grand section, and were then taken forward into the mountains.

From this point onward the line afforded a constant succession of studies for the geologist which could not fail to arouse his enthusiasm. The boldly-bedded character of the strata, with the planes often picked out by new snow, the steepness of the slopes, and the absence of vegetation, combined to bring out with the utmost distinctness details of structure which ordinarily can be discovered only after infinite labour and research. Infold and overfold, syncline and anticline, thrust-plane and fault were alike visible. Under such conditions the study of mountain-structure acquired a fresh significance, and even those of us who before had paid no attention to the subject now pursued it with zest.

The general character of this region is summed up as follows in the admirable report of Mr. McConnell[1]:—"This portion of the Rocky Mountains . . . is characterised in its eastern part by a series of great fractures and thrust faults, in the centre by broad sweeping folds, and in the west by folding and crumpling, accompanied by the development of cleavage-planes and a limited amount of metamorphism. Among its other more important features may also be noted the absence of recognisable unconformities, the absence of any of the older crystalline schists, the relatively smaller amount of disturbance in the central parts of the range than towards the edges, the want of similarity in the sequence of the formations east and west of the axis, and the marked preponderance of calcareous beds between the Middle Cambrian and the Cretaceous."

Our course lay up the Bow Valley, which is here carved out of a trough of Cretaceous rocks, wedged in among and apparently overlain by Cambrian strata. In this trough coal is mined, and although on the Plains the coal of Cretaceous age is lignite of poor character, the quality improves as the mountains are approached, until in this district both bituminous coal and anthracite are obtained.

Not only in geological interest but also in the beauty of its mountain scenery the Canadian Pacific is undoubtedly far superior to any other line crossing the North American continent. We were here within the limits of Canada's Rocky Mountain National Park, and the views we now obtained delighted us. Arriving at the well-known tourist centre, Banff, about noon, and establishing ourselves at the large new C.P.R. Hotel, where we found Prof. John Macoun of the Canadian Survey awaiting us, we set about to make the best of our time. A ridge, known as Sulphur Mountain, rising 3000 or 4000 feet above the valley to the west of the hotel, proved attractive to the more energetic of our party, and although Prof. Macoun had already made the ascent earlier in the day, he expressed his readiness to start again, and undertook the leadership of the group. For the others, who were content to view the many points of interest in the beautiful valley, carriages were provided.

From the grand outlook on the crest of Sulphur Mountain the chief features of the region were readily grasped. The Bow River far below us broke across the range, while on either hand were deep longitudinal valleys running between tilted orographic blocks of Palæozoic limestones, out of which a succes-

[1] Canadian Survey Reports for 1886, vol. ii. Report D, p. 40.

sion of mountainous ridges had been carved, all with precipitous faces to the east, and long dip-slopes to the west. Near the summit, about 8000 feet above sea-level, there were distinct traces of glaciation, apparently transverse to the ridge.

A hurried descent put us into fit state to appreciate the luxury of a bath from one of the hot sulphur springs, already celebrated for their restorative properties, which well up along a line of fault at the foot of the mountains. Then after a reunion at the hotel we retired once more to the "Chaudière," which had begun to assume quite a home-like aspect.

Early on the following morning, September 3, the west-bound train took us again in tow, our course for some time following up the Bow River amid scenery of increasing splendour, with glaciers showing here and there in the mountains ahead. Then, turning westward up a small tributary, the train entered the Kicking Horse Pass; and soon a painted signboard announced the Continental Divide; and we breakfasted at Field Station on the Pacific slope, with the shapely Mount Stephen just above us. From this point onward the geological structure became more complex, the foldings more acute, and the outline of the mountain peaks less and less dependent upon the bedding, and in running down the beautiful valley of the Wapta or Kicking Horse to the Upper Columbia depression we passed into the region of complication and alteration which forms the core of the mountain ranges. Thenceforward to the Pacific coast the task of the travelling geologist is difficult, and but for the work which has already been published on the Selkirks and Coast Ranges, and the presence among us of the man who had done it, we should have been at a loss to understand what we saw.

The Columbia River was reached at Golden, and was followed thence north-westward to Beaver Mouth. The great terraces of stratified material which line its valley up to high levels attracted attention both here and at Revelstoke, where the railway again crosses the river below its great north bend. Leaving the Columbia, our track turned south-westward, up Beaver Creek and Bear Creek, to make its difficult traverse of Selkirk Range. The Palæozoic rocks had now undergone a great change of character, and instead of the flaggy limestones of the Eastern Rockies, we found ourselves among unfossiliferous argillite schists and quartzites, everywhere highly disturbed and sheared. The denser timber and the many long snow-sheds lent additional obscurity to our geological impressions.

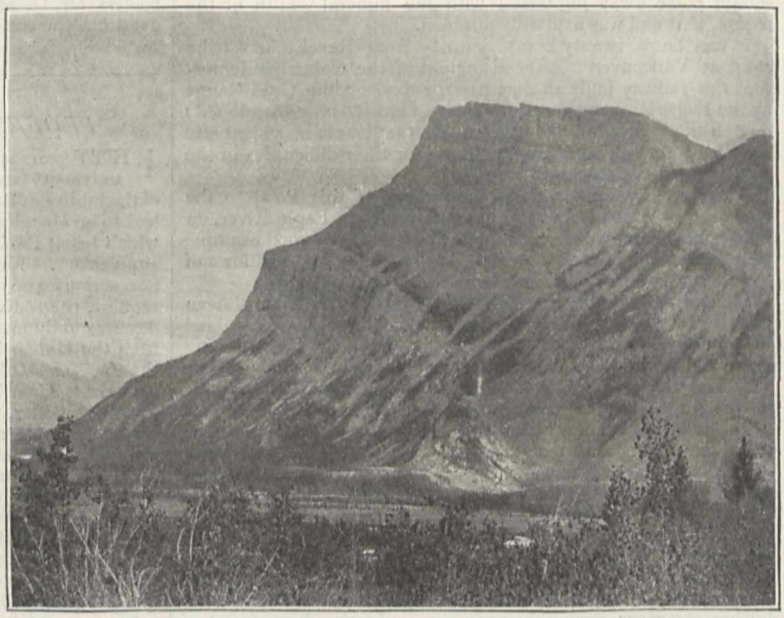
Around Rogers' Pass, 4300 feet above sea-level, lies the finest mountain scenery of the whole route, but on this day the highest tops were hidden in clouds. A short run from the summit brought us, at 2 p.m. or 14 o'clock railway time, to our next halting-place, the C.P.R. Hotel at Glacier.

At this place our first objective was, of course, the grand Illicilliwaet Glacier, the snout of which lies two miles back in the forest. Around the glacier a busy afternoon was spent—one of our party, expert in such work, fixing points for measuring its future recession; others scaling the lateral moraines of blocks of sheared quartzite in which blue quartz grains were conspicuous; others attacking the glacier itself, and studying the fine display of structures which the body of the ice reveals. But the time was, of course, too short for more than a mere skirmish around its lowermost portion, and the great icefields above remained unseen.

It had been proposed on the following morning to climb one of the ridges overlooking these icefields; but here for the first and only time the weather failed us, and though after breakfast Prof. Coleman, who made light of all obstacles, led the way towards the Asulkan, another of the many glaciers of this region, he found but few followers to face the discomfort of the saturated forest.

Some curious feats in engineering have been performed in carrying the railway down the western slope of the Selkirks, but none are more remarkable than the great "loops" by which the descent is made from Glacier into the cañon of the Illicilliwaet. After leaving this place we had all around us the heavy timber of the Pacific region, making, where unburnt, a fine foreground to the peaks and glaciers behind. But the wholesale devastation which has been wrought by forest fires throughout this region is distressing to any eyes but those of the Western man who has come to regard timber as the chief hindrance to the rapid development of his country.

At Albert Cañon the train stopped long enough to allow our photographers to spoil their plates in attempting views of a sombre river-gorge. At this point the dark schists with a band of crystalline limestone (part of the "Nisconlith Series" of Dawson) are believed to lie very near the base of the sedimentary rocks of the Selkirks. At any rate, a short distance further west we entered upon the region of gneiss, mica-schist and granite, which the Canadian geologists recognise as a portion of the Archæan nucleus or axis. Out of such rocks the western part of the Selkirks and much of the Gold Range have been carved. We found opportunities to examine them, during the return journey, at a few points around Revelstoke and Arrowhead, and from their intricate structures one might judge that several different stages of movement and several distinct periods of eruption were represented. Unlike the conditions in Eastern



[*From a photograph by Prof. H. E. Armstrong.*

FIG. 2.—The eastern face of Mount Rundle, Banff.

Canada, in British Columbia westward of the Selkirks the Palæozoic and even Mesozoic rocks are so involved and altered among eruptive and intrusive masses, and so implicated with each other by the earth-forces which have built up the mountain-ranges, that the evidence for age is rarely at hand, and one would need to be thoroughly well acquainted with the country to pronounce upon any part of it. But one could see that these schists and gneisses form the Central Complex of the ranges; and they seem of high antiquity. In travelling from east to west across the mountains we had seen the effects of crustal forces of gradually increasing intensity, acting usually from west to east. We were now upon the focus of these forces, where their intensity had obscured the evidence.

At Revelstoke, the same evening, the Columbia was crossed for the second time, the great river flowing south-easterly here, instead of north-westerly as where we had crossed it on the previous day, on nearly the same latitude, but about 150 miles nearer its source. The valley systems of this part of the continent are peculiarly interesting for the physiographer, and present some curious problems which are yet unsolved. In this instance the Columbia and its great tributary, the Kootenay, have their sources close together in the same great valley: the one flows north, and then swings round sharply southward; the other

flows south, and swings northward to their union, the Selkirks and associated mountain ranges being thus completely encircled. Among our party were those who have struggled bravely with such problems, and to their investigations we shall look for further enlightenment.

From Revelstoke the C.P.R. Company has a line of communication by rail and steamboat into the celebrated West Kootenay mining district, by way of that beautiful expansion of the Columbia River known as the Arrow Lakes. Through the liberality of the British Columbian Government, side-excursions were organised into this region, and on our return from Vancouver the majority of our party took advantage of the opportunity to visit the brand-new mining town of Rossland, around which are grouped the chief mines of the district. Here, as everywhere else in the province, every facility was afforded us to see all that was best worth seeing. We visited such well-known mines as the Le Roi, War Eagle, Centre Star, &c., where large deposits of auriferous chalcopyrite and pyrrhotite occur, chiefly in veins near the margin of a mass of gabbro intrusive into Palæozoic rocks. The large smelter at Trail, on the Columbia Railway, a few miles distant, was also visited; and those of us who could spare the time went afterwards into the Slocan country, where the richest mines of silver-lead occur. Space forbids a detailed account of these and other branch excursions in the Province; but if it was intended that we should come away impressed with the mineral wealth of the region, that end was assuredly attained.

It was but a twenty hours' journey from Revelstoke to the coast at Vancouver. After rising out of the Columbia depression the railway finds an easy passage through the Gold Range by the Eagle Pass, apparently a valley of erosion now abandoned; though the suggestion had been made that it was providentially supplied to compensate the engineers for their difficulties in the Selkirks and the Rockies.

A chain of small lakes fills the summit of this Pass, to the westward of which lie many fine moraines. In Eagle River, on its western slope, we were fortunate in witnessing a good example of a salmon run, shoals of great fish crowding the shallows of the stream in every part, and lying dead on every bar.

Shuswap and Kamloops Lakes, and the dry interior plateau of British Columbia with its Tertiary volcanic rocks, were passed in the night, and at daybreak of September 5 we were running down the picturesque cañon of the Thompson River, near its junction with the Fraser. In the Fraser Valley itself there is in this neighbourhood a sharp infold of Cretaceous strata; but lower down we saw only ancient-looking slates, supposed to be Cambrian, along with masses of igneous rocks, both of acid and basic types. Near North Bend, where we breakfasted, a dredger was at work raising the auriferous gravel from the river bed. Below this the valley narrows, and the Fraser races southward for miles through a magnificent cañon, down which the railway also passes. Then, at Yale, the river bursts out of the mountains and swings round westward into a broader and apparently much older valley, which it follows from Hope to the Pacific. Following the river, our track went now amid the dense forest of gigantic trees with which the valley is filled, cleared spaces being as yet quite scanty. Of the Laramie or newer rocks which underlie the Fraser delta, we saw nothing, as on the low ground there is everywhere drift and alluvium. Reaching Pacific tide-water at the head of Burrard's Inlet about noon, we drew up at Vancouver half an hour later.

Our long delightful railway journey was completed, and with it our transverse section of the continent. Starting within the Appalachian rim, we had seen, to the east of the prairies, the old Archæan floor on which the Palæozoic strata rested almost undisturbed; then the prairies themselves, with their vast expanses of horizontal, unfaulted Mesozoic rocks; then the foothills, with the same rocks thrown into wavelike swells; then the outer mountains, with dislocated and overthrust masses of various ages, driven eastward from the centre of disturbance; then the inner ranges, with crumpled and altered strata whose age was no longer determinable, and with the central core of metamorphic and plutonic rocks; and then again, to the westward, infolded and crumpled sediments with many igneous interruptions.

All this had, of course, been described for us already by the Canadian geologists in their admirable official and other publications. But what literature could hope to convey an adequate impression of such a region to one unacquainted with it?

At Vancouver most of us took boat at once across the Straits of Georgia, a few on whom time pressed crossing to Nanaimo, and the majority going first to Victoria, whence a special excursion was afterwards made to Nanaimo. It was a glorious afternoon for the passage—the mountains around Howe's Sound half hidden under storm-clouds and half revealed, and a foreground of high gloomy shores, with the deep recesses of the fjords within gleaming with mysterious light.

On Vancouver Island the heartiest hospitality again awaited us, but of our doings there is small space left to tell. In Victoria we found many of our friends of the two earlier parties, and we of the "Chaudière" held a banquet to do honour to our leaders Dr. Dawson and Prof. Coleman. On Monday we were taken in carriages to the points of chief interest in the vicinity of the city; on Tuesday there was a special train to take us to Nanaimo, where coal of excellent quality is extensively mined from rocks of Cretaceous age; and on Wednesday a number of those who intended to visit the Kootenay started for the mainland. Safe to say that we all left the city of Victoria with reluctance, as most do who visit it.

And now the unity of our party was lost, and its fortunes need be no further followed. For all of us this had been a memorable journey, and we started homeward with a lively sense of gratitude to the Local Committee at Toronto, to the Provincial Governments of Ontario and British Columbia, to the Canadian Pacific Railway Company, and, above all, to our leaders Dr. G. M. Dawson and Prof. A. P. Coleman, by whose exertions the complete success of the excursion was secured.

PROFESSOR VIRCHOW'S JUBILEE.

FIFTY years ago Prof. Virchow delivered his first lecture as a university teacher, and preparations for celebrating the event of the jubilee at Berlin last week had been made, but unfortunately had to be abandoned in consequence of a sudden attack of illness which befell Prof. Virchow whilst lecturing two days before the anniversary. Naturally some alarm was felt, but the attack was not serious and passed off quickly. However, at Virchow's request, the festive arrangements were countermanded, and the day was only marked officially by a congratulatory deputation from the University. According to the Berlin correspondent of the *British Medical Journal* the deputation consisted of the deans of the four Faculties, and nearly all the medical professors. Prof. Schmoller, the University Rector, spoke first, and in a warm and able address praised Virchow as the benefactor of millions, and as the great instructor whose methods had gradually permeated almost all schools of thought. Then followed Prof. Heubner, the Dean of the Medical Faculty. He spoke of Virchow's strong personality, and described the commanding impression caused by his teachings which had revolutionised medical thought. It was true that what might be called Virchow's greatest lifework was the introduction of "methodology" into medicine, but this alone did not explain his immense influence. He had pre-eminently the genius of research, and had traded with his talent as a faithful steward. At an age when others had not finished their studies he had attacked scientific problems with his bold and strong intellect, had gone on from problem to problem, until after ten years his work was crowned by the completion and publication of his "Cellular Pathology." Since then he had become the *præceptor mundi* in medicine. Prof. Virchow, in reply, modestly disclaimed what he called excessive honours. He said he felt like a plant from which the withered leaves had been removed to give it a better appearance. He could not deny that his work had always been full of zeal, and supported by the endeavours to keep in view universal principles; and it was true, also, that a certain soberness of judgment had helped him over great difficulties. If he had succeeded earlier than others in forming a school, he owed this to his recognition of the fact that it was impossible to do everything oneself, and to his success in creating a sort of phalanx for his ideas, which had been of sufficient force to overcome resistance, and to prepare a broad basis for later developments. And thus, he was happy to say, he now felt himself no longer indispensable as representing his school, since there were a sufficient number of men sharing his views. He hoped that his little attack of the day before would have no further consequences, and that he had yet some time for work before him; still he could not hide from himself that it was now time to make a stop, to a certain extent; and therefore he was

doubly glad that he had lately succeeded in convincing the Government that somewhere in Germany there must be a place where every student could at all times find instruction on questions of pathology and medicine, that he had been instrumental in securing the rebuilding of the pathological museum.

THE TEMPERATURES OF REPTILES, MONOTREMES AND MARSUPIALS.[1]

THERE has for many years past been a tendency to diminish or ignore the distinction between the cold-blooded and the warm-blooded types of animal life. Yet the difference is one that is not only real, but in some respects radical. In very few, however, of nature's classes is there found a line of sharp demarcation, and the chief purpose of this paper is to point out that, though the distinction between the two types is real, there lies between these two types a line of steady gradation.

Although the invertebrates have the capacity of producing heat, they are themselves cold-blooded. With the exception of the insects, they very rarely rise more than a fraction of a degree above the temperature of the media in which they happen to be. According to observations of Prof. Valentin, polypi, medusæ, echinoderms, molluscs, crustaceans and cephalopods are able to raise themselves about a fifth of a degree, sometimes as much as three-fifths of a degree, above their environment.[2]

Among insects the power of heat-production is very much greater. Though essentially cold-blooded creatures, in the sense that they have no fixed standard of body-heat towards which they approximate, they are almost always warmer than their media; but if they are at rest that excess is only a degree or two. In case, however, of severe exertion, they are capable of warming themselves to a remarkable extent.

In the case of fish, amphibia and reptiles the same is true. At rest all of them remain at the temperature of their environment, rising and falling with it, and showing no capacity, however rudimentary, of maintaining a fixed and characteristic temperature; yet all can warm themselves by exertion. The large blue-tongued lizard, which is common in the southern parts of Victoria (*Cyclodus gigas*), can warm himself as much as half a degree in ten minutes of anger. In five experiments of this sort I found that different individuals had different capacities of being irritated, but the average was a trifle under half a degree for ten minutes of exasperation.

By activity, and consequent heat-production, all fish, amphibia and reptiles seem able to keep themselves a little warmer than the air or water in which they dwell. Dutroche tells us (*Ann. des Sciences Nat.*, xiii. p. 20) that the newt can keep itself from 2° to 5½° above the temperature of its medium, the turtle 1½° to 3½°, and the common green lizard of France (*Lacerta viridis*) from 4° to 7°. Max Fürbinger asserts that species of blind-worm rise as much as 8° above the temperature of the air. Fish at rest appear to take almost absolutely the temperature of the water wherein they live, but after a struggle, or any other form of energy, they may warm themselves two or three degrees.

This, however, has no real affinity with a warm-blooded habit. And yet these creatures approach in a remote way the warm-blooded condition by sometimes developing a capacity for heat-production in the action of their viscera. Dumeril has shown that snakes by mere digestion can warm themselves from 2° to 4°, the maximum temperature occurring about twenty-four hours after a meal.

Thus it constantly happens that these animals, though essentially cold-blooded, may be observed at temperatures somewhat above that of their environment. But in general that excess is not great, and it leaves the distinction between the warm-blooded and the cold-blooded type quite unaffected.

The true criterion of the difference is of course the concomitance of the temperature of the animal and its medium. An animal of the warm-blooded type may vary a trifle in its general body temperature when the climate alters, but it maintains an almost constant degree of heat. The reptile, though it may maintain itself a few degrees above the surrounding temperature, always varies with it, rising and falling so as to keep always the same number of degrees in excess.

To see how far this concomitancy held, I placed two specimens of the large lizard already mentioned into a small tank of water, so that only their noses were above water. I then warmed up the water at various rates of speed by means of one or more lamps. The accompanying diagram (Fig. 1) shows how closely the lizards followed the temperature of the enclosing water.

Cyclodus gigas is a very sluggish creature, and if left alone never warms himself by any exertion, yet if one takes his temperature in the early part of the day it will almost always be found to be below that of the air. After sunset it is generally higher. During two years I kept specimens of this species in a box, sometimes six or eight, sometimes only two or three. I took their temperatures morning and evening, not altogether continuously, but throughout the larger portion of that time. The average of all these observations gave for lizards 18°·1, for the air 18°·4. This is a very close approximation considering that the temperatures had the wide range that lies between 12° and 32°. The lizards appear to be a little colder than the air. This I believe to be due only to the fact that, taking temperatures before eight o'clock in the morning, the lizards were still considerably in the rear of the temperature, while between five and six o'clock in the evening, though they were above the air temperature, the excess then did not wholly balance the morning deficiency.

I am convinced that if one took the temperature of a quiet lizard every hour for a month, the average would correspond

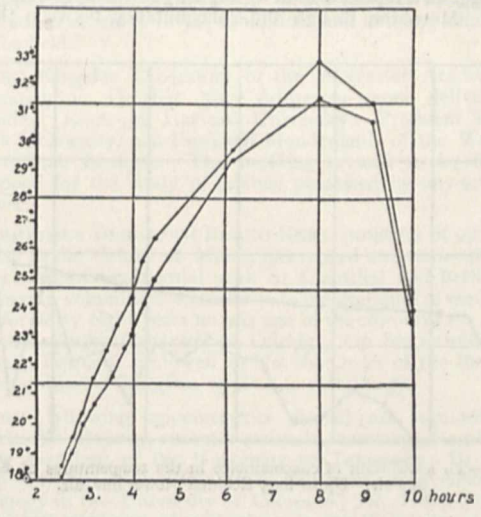


FIG. 1.—To show concomitance of temperatures of lizards and water. Upper line, temperature of water; lower line, temperature of lizards.

almost exactly with the average temperature of the air. The morning and evening observations which I took would give a less exact result, though from them the difference is only three-tenths of a degree.

The steps whereby the more active and intelligent warm-blooded types have arisen from the lethargic level would form a fascinating subject for inquiry, but I purpose here only the much easier and more prosaic one of recording that such steps, however caused, do actually present themselves, and that these are in the most perfect accordance with the existing classification, which is based on anatomical considerations alone.

The monotremes are, in consideration solely of their more reptilian anatomy, placed lowest in the scale of mammals. Their low temperature would entirely justify, were justification in any way needed, the position thus assigned them next to the reptiles. The temperature of the duck-billed platypus has been determined by Baron Miklouho-Maclay to be, as the average of three observations, 24°·8 when the water in which the animals were kept averaged 22°·2 (*Journal* of Linnean Society of N.S.W., viii. p. 425, and ix. 1204.)

Now, the average of forty-five specimens of the ten higher orders of the mammalia, excluding the monotremes and marsupials, is 38°·9, as calculated from Dr. John Davy's lists (*Edin. Phil. Journal*, 1825, p. 300), while the average of a similar but shorter list supplied by Max Fürbinger is 39°. We

[1] By Alexander Sutherland. Abridged from the *Proceedings* of the Royal Society of Victoria vol. ix. (New Series), 1897.

[2] All degrees in this paper are Centigrade.

may take this as fairly indicative of the general mammal temperature, which does not, except in constitutional disturbances, vary so much as two degrees on either side of this limit. No mammal indeed seems in good health to be warmer than 40°; scarcely any descend lower than 37°.

The platypus, therefore, at only 24°·8 is almost a cold-blooded animal. The only other genus of monotremes, the echidna, carries us a step upwards. Baron Miklouho-Maclay's average of five observations is 28°, while the air was 20°. I have kept at different times fourteen specimens of *Echidna hystrix*, and made twenty-seven observations on the temperatures of all I happened to have at any particular time. I found the average to be 29°·4, or nearly a degree and a half above that of the Baron. But these animals show their affinity with the reptiles by a temperature so variable with the weather that we may readily expect the average of one series of experiments to differ very considerably from that of another.

An echidna one cold morning was as low as 22°; another, brought in from the forest in a sack exposed to a fierce midday heat, registered as high as 36° 6. The accompanying diagram (Fig. 2) represents the general character of the variations, the temperatures in each case being the average of from three to six individuals, which never vary from one another at the same time more than a fifth of a degree.

It will be seen that the temperatures of the echidnæ varied from 22° to 36°·6. This is an immense range for a mammal, and suggests a reptilian want of capacity for temperature regulation. Moreover, though the concomitancy between the air

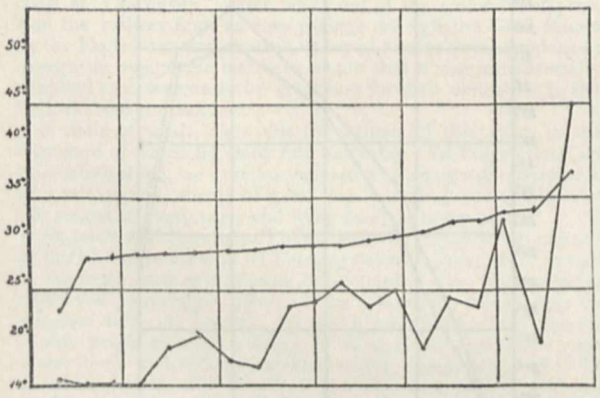


FIG. 2.—To show want of concomitance in the temperatures of Echidna and air. Upper line, Echidna; lower line, air.

and the body temperatures is by no means strict, there is enough to show that the one in a large measure follows the other. It is to be remembered that while a monotreme may rise and fall with the air, yet the one change will follow the other after a definite period of time, and an hour after sunset, though the air in a box may have grown much cooler, the echidnæ in that box may have only begun to cool.

The next stage in the anatomical classification brings us into the order of the marsupials, and here again we make an upward step in view of a temperature higher, but not so high as that of mammals in general; steadier, but not so steady as is usual in all the remaining orders. I have observed the temperatures of sixteen different species of marsupials, and they average 36° exactly, as the result of 126 observations. They are thus 3° below the average of other mammals.

The marsupial whose temperature, so far as I have observed, comes next above the monotremes is the wombat, which stands at 34°·1, as the average of single observations made on two specimens (*Phascolomys lasiorhinus*, 34°·3, and *P. platyrhinus*, 34°). Next seems to stand the genus Petaurus, or flying squirrel. Mr. Ernest Le Souëf was good enough to observe for me the temperatures of five specimens in the Zoological Gardens of Melbourne. The average is 35°·7.

After that comes the genus Phascolarctos, our little native bears or koalas. I have kept numerous specimens of this animal (*P. cinerus*) on his native gum trees, with nothing artificial about him save a strap and rope whereby he could be pulled down from time to time to have his temperature observed. Thus I made eighty-three observations, the average of which amounts to 36°·4. Females at the breeding time are always very decidedly above the ordinary degree of warmth. If such cases be excluded, the average is exactly 36°. But the average for males alone is only 35°·2. The range of variation may be seen in Fig. 3.

The range is not very wide, yet I have often known healthy specimens that had been for a while in the sun stand as high as 37°·9, while on a cool day or in a very shady place the same individuals would be only 35°·3, a range greater than we would find under the same circumstances in any of the higher mammals. The highest register I ever obtained for a thoroughly healthy koala was 38°·4, which is a degree and a half above the normal temperature of man; the lowest was 34°·9, or nearly two degrees below man's normal.

According to observations taken for me by Mr. Ernest Le Souëf, the Dasyures come next at an average of 36°.

Phalangers stand next in order. The average of twenty-two observations on from two to four specimens of the ring-tailed opossums (Phalangista) gave 36°·6, which is only a little below the normal human temperature. But again the range was much greater than one finds in any of the higher mammals. In cool weather, with the thermometer at 16°·8, a male would register about 35°, a female about one-tenth of a degree higher; but in warmer weather, though still in the shade, where the thermometer registered 31° to 35°, the opossums would be about 37°.

Mr. Ernest Le Souëf took for me the temperatures of three of these Australian opossums in the Melbourne Zoological Gardens. *Phalangista vulpina* gave 36°·1, *Phalangista fuliginosa* 37°·3.

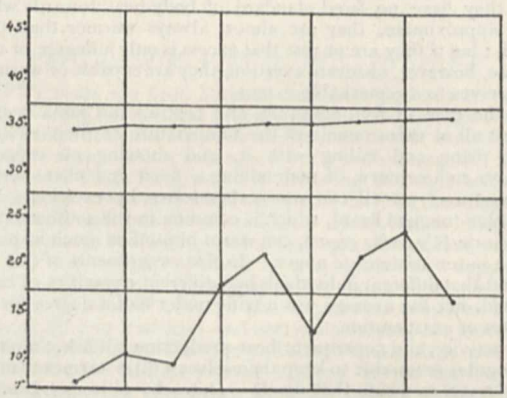


FIG. 3.—To show want of concomitance in the temperatures of Koala and air. Upper line, Koala; lower line, air.

This corresponds with Selenka's observations of the true opossums (Didelphys), which ranged about 37°.

I have made only four observations on the temperatures of the kangaroo family. They are a little under the human standard. *Macropus giganteus* gave 36°·6, *Halmaturus bennettii* gave 37°·1, *Petrogale xanthopus* 35°·9, while the tree kangaroo (*Dendrogalus grayi*) was exactly at the human standard, 37°.

From the few recorded temperatures of rodents and insectivores, I should think it most probable that they came next in order, with perhaps the Cetacea and Sirenia, judging from occasional records, as almost on the same level. All the other orders of mammalia stand uniformly much above the human temperature.

It is clear, therefore, that there are grades of temperature, and that the mammals which are classed lowest on anatomical grounds are not only of the lowest temperature, but also of the greatest range, and they are likewise, of all mammals, those which are under the strongest and most direct influence of the temperature of the environment.

Similar, though much less complete connecting links may be seen in the case of birds. The lowest of birds are the Ratitæ, or Cursores, and these appear to have the lowest temperature. Mr. Ernest Le Souëf took for me in the Melbourne Zoological Gardens observations on the temperature of the emu. These are the lowest records of bird temperatures of which I know. They averaged 39°·5, while all the birds above the Ratitæ are invariably over 40°. The temperature of thirty-six fowls, taken quietly by night from their perches, averaged 41° exactly, while that of twelve, lifted from the nests in which they were brooding,

was 41°·4. Numbers of fowls caught while roaming about averaged 41°·3, but these of course were always warmed up previously by a little violent exercise. Turkeys stand about the same level; ducks are stated, on good authority, to be lower; but I have found for these birds, from a fairly large number of observations, an average of 42°·1. The temperatures of birds of the more intelligent orders is generally somewhat higher. If we exclude the birds of prey, we might say that in all orders above the anseres, grallæ and gallinæ the temperature ranges over 42°. It would be a matter of interest to secure some observations of the temperature of the apteryx, in order to determine whether the lowest of birds shows by its body warmth in some degree the same reptilian affinity which the monotremes exhibit. In that case there would be reason to believe that the rest of the Ratitæ would correspond closely to the Marsupials, being a connecting link, but much closer to the higher forms than to the lower.

In a very general way, and not forgetting numerous limitations and contradictions, it may be said that bodily activity depends on body temperatures, that creatures such as insects and reptiles are active only when warmed up from without, but become torpid with decreasing temperature. The type in which activity is generally habitual, maintains its own body temperature. This is seen in the mammals, but more still in the birds. But this warm-blooded active condition was produced by no sudden emergence; the monotremes and marsupials form a gentle gradation between the reptile and the carnivore or ungulate: while, so far as indications point, there is reason to believe that the lower birds still are reminiscent of a once existent chain of links which equally joined the cold-blooded lizards to those warmest-blooded of all creatures, the passeriformes and fringilliformes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. W. T. Brooks has been appointed Litchfield Clinical Lecturer in Medicine.

The Welsh Prize for Human Anatomy for 1897 has been awarded to Mr. A. T. Waterhouse.

W. K. Spencer, of Batley Grammar School, has been elected to a Demyship in Natural Science at Magdalen College, and A. J. Webb, of Dulwich College, to an Exhibition.

Convocation has conferred the degree of M.A., by decree, on Mr. A. A. Rambaut, the newly-appointed Radcliffe Observer.

Prof. Gotch and Dr. Buckmaster have been appointed Examiners in Physiology, and Prof. Allbutt and Dr. Ormerod in Medicine for the M.B. Examinations from 1898–1900.

Mr. N. V. Sidgwick, Ch. Ch., is President of the Junior Scientific Club for the present term. The other officers are: Treasurer, Mr. A. E. Boycott (Oriel); Editor, Mr. A. R. Wilson (Wadham); Secretaries, Mr. A. Hartridge (Exeter), and Mr. F. Nunneley (B.N.C.).

CAMBRIDGE.—Dr. Shore, of St. John's College, has been appointed Chairman of the Examiners for the Natural Sciences Tripos, and Dr. Hobson, of Christ's College, for Part II. of the Mathematical Tripos.

The Arnold Gerstenberg Studentship, for natural science students who distinguish themselves in Moral Philosophy, has been awarded to Mr. C. F. G. Masterman, of Christ's College.

By the will of Mr. Joseph Gedge, M.B., who died at Khartoum in 1870, while acting as medical officer to Sir Samuel Baker's expedition, a sum of 1000*l.* has now come to the University for the foundation of a biennial prize in Physiology. The recipient is to be a graduate of the University of not less than five or more than seven years' standing from matriculation, who sends in the best essay embodying original observations in physiology, including histology, physiological chemistry, and physiological physics. If the prize is not awarded on any occasion, the accumulated income of the fund is to be given to the Museums of Anatomy and Physiology.

At St. John's College the following awards in Natural Science have been made to students not yet in residence:—80*l.* scholarships, Williams, of Pocklington School, and Wakely, of St. Olave's School; 70*l.* scholarship, Gregory, of University College, Bristol; 50*l.* minor scholarships, Crocker, of Llandovery College, and Macalister, of Charterhouse; 50*l.* exhibition, Browning, of Dulwich College.

At Trinity College the corresponding awards are as follows:—75*l.* minor scholarship, Harrison, of Royal College of Science, London; 50*l.* minor scholarship, Hamill, of St. Paul's School; 40*l.* exhibitions, Keeling, of Bradford School, and Scott, of Rugby School; sizarship, White, of Royal College of Science, London.

THE death is announced of Dr. Arthur Scheffer, formerly professor of chemistry and medical physics in the University of Kieff.

THE Calendar for the seventeenth session (1897–98) of the University College, Nottingham, has just been published at Nottingham by Mr. J. Sands.

MR. ARTHUR HAMILTON WHITE has been appointed professor of pathology in the school of the Royal College of Surgeons, Ireland, in the place of Dr. Thomas Myles, resigned.

A LABORATORY for experimental psychology has been opened, under the direction of Dr. W. O. Krohn, in the Illinois Eastern Hospital for the Insane, at Hospital, Ill.

AT a meeting of the Court of the Victoria University, held at Owens College, Manchester, Prof. D. J. Leech was re-elected a member of the Council. It was resolved: "That the colleges of the University be invited to take such steps as may be necessary to secure the inclusion of the colleges in the list of institutions at which Royal exhibitions and national scholarships can be held."

THE Kingsley Laboratory of the Worcester Academy was dedicated on October 30. Addresses were delivered by President Eliot, of Harvard University; President Hall, of Clark University, and President Mendenhall, of the Worcester Polytechnic Institute. The building is said to be the best equipped for the study of science possessed by any secondary school.

GEHEIMER BERGRATH BRUNO KERL, professor of metallurgy at the Berlin School of Mines, has retired after more than fifty years constant professorial work at Clausthal and Berlin. He has been a voluminous contributor to the literature of metallurgy, and for thirty-eight years he was one of the editors of the *Mining and Metallurgical Journal* of Leipzig. On his retirement the German Emperor bestowed on him the Order of the Red Eagle in recognition of his great services to metallurgy.

THE following appointments abroad are noticed:—Dr. Charles W. Dabney, recently assistant secretary of agriculture, to be president of the University of Tennessee; Dr. Arthur Allin, of Ohio University, to be professor of psychology and pedagogy in the University of Colorado; Dr. Hermann Munk to be full professor of physiology in the University of Berlin; Dr. Hettner, of Leipzig, to be assistant professor of geography in the University of Tübingen, Dr. Max Busch to be assistant professor of analytical chemistry and chemical technology in the University of Erlangen; Dr. Zwaardemaker to be professor of physiology in the University of Utrecht; Dr. Frank K. Cameron, late associate professor of chemistry in the Catholic University of America at Washington, to be research assistant in physical chemistry in Cornell University; Dr. O V. Darbishire to be lecturer (privat-docent) in botany at the Prussian University of Kiel; Dr. A. R. Hill has been appointed to succeed Prof. Wolfe at the University of Nebraska. The chair vacated by Prof. Hill at the Osh-Kosh Normal School has been filled by the election of Dr. F. D. Sherman.

THE Report of the Council of the London Society for the Extension of University Teaching, for the session 1896–97, has reached us, and is of an encouraging nature. The number of courses for the session under review was 160, as compared with 148 for 1895–96, and the number of students for the two periods, in the order named, was 14,150 and 13,238. The slight falling off in the number of certificates awarded (1807 in 1896–97, as against 1906 in 1895–96) is explained by the alterations made in the Regulations of the Education Department with regard to the Queen's Scholarship Examination. Candidates are now only allowed to take the University Extension examination as an alternative to the Queen's Scholarship examination in the same subject, whereas formerly the possession of a sessional certificate secured a block of sixty marks in addition to those obtained in the ordinary examination. The Council anticipated

that this alteration would make a much greater difference in the number of pupil-teachers working for sessional certificates than has been the case. They have been much gratified by the enthusiasm shown by the heads of pupil-teachers' centres with regard to University Extension teaching, in their efforts to keep in connection with the Society under the altered conditions. Pioneer courses of lectures, the expenses of which have been borne by the Technical Education Board of the London County Council, have been given at Bethnal Green, Poplar, Queen's Park, St. Pancras, Shoreditch (two courses), Walworth (two courses), and Wandsworth. These courses were attended by about 3500 people, almost exclusively of the artisan class. The average attendance at each lecture was 387. In two of the districts regular extension centres have been formed as the result of the lectures. In connection with these courses the illustrations of scientific principles are largely drawn from the industrial developments of the district with which the working men are particularly acquainted. Thus the course on "Electric Power and Lighting," given by Dr. Laurie at the Town Hall, Shoreditch, in the Lent Term, was fully illustrated by views of the Shoreditch electric installation, and created an intense interest in the subject among the working men, who attended in great numbers. A large proportion of the audience remained for class instruction after the lectures; many did regular weekly paper work, and forty obtained the certificates of the Society as the result of the terminal examination.

SCIENTIFIC SERIALS.

American Journal of Science, November. — Geology of Southern Patagonia, by J. B. Hatcher. This is an account of the results of an expedition into Argentine Patagonia made for the purpose of collecting vertebrate fossils for Princeton University. The oldest sedimentary deposits seen were a series of black, very hard, but much fractured slates, with Ammonites fairly abundant, but not sufficiently well-preserved to admit of identification. These beds are referred to the Jurassic, chiefly on account of their lithological characters and the great thickness of the overlying rocks, which, to judge from Dinosaurian remains, can hardly be more recent than the Cretaceous. The beds of basalt observed by Darwin on ascending the Santa Cruz River are not due to a flow from the distant Cordilleras, but to small local craters.—The former extension of the Appalachians across Mississippi, Louisiana, and Texas, by J. C. Branner. Gives additional facts in support of his thesis that the old Appalachian land area crossed what is now the lower Mississippi valley. The coal-measures drainage of the Illinois-Indiana-Kentucky basin flowed westward through the Arkansas valley into a carboniferous Mediterranean sea. The drainage of the coal-measures region south of the Ouachita anticline flowed westward and entered this sea north of the Texas pre-Cambrian area. The drainage of both the Arkansas and Texas carboniferous areas was reversed about the end of Jurassic times, when orographic movements over south-east Arkansas, eastern Texas, Louisiana, and Mississippi submerged the former extension of the Appalachian watershed, and admitted the early Cretaceous sea across the Palæozoic land as far north as southern Illinois.—The combustion of organic substances in the wet way, by I. K. Phelps. Carbon dioxide may be estimated iodometrically with a fair degree of accuracy. It may, therefore, be applied to the determination of organic carbon oxidised by liquid reagents, such as potassium permanganate or chromic acid. The former was used for oxidising oxalates, formates, and tartar emetic; the latter for these and cane-sugar and paper. The method is very successful in the case of the less volatile organic compounds.—Some features of the pre-glacial drainage in Michigan. In all the glaciated area of North America no region is so extensively and deeply covered with drift as the lower peninsula of Michigan. The author works out the probable features by analogy with unglaciated areas, and constructs a map showing the probable carboniferous river system.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Observation of Zeemann's phenomenon, by W. König. The author observes the dark sodium lines produced by an arc light traversing a sodium flame. The broadening in a magnetic field is detected by a differential method. A quarter-wave plate and a doubly-refracting prism are used to obtain two images of the slit joining across a narrow line. The extinction of the circularly-polarised right-hand edge in one image, and the left-hand edge in the other, gives the appearance of a lateral displacement which is reversed by turning the prism. A total displacement of 1/28th of the distance between the D lines is thus obtained in a field of 7300 units.—On the rate of depolarisation of electrodes and on dielectric constants at low temperatures, by R. Abegg. This is a criticism of Dewar and Fleming's alleged enormous capacities of certain dielectrics at very low temperatures. The author maintains that these are only apparent, and are really due to the very slow depolarisation of electrodes in great cold, so that the current obtained from the condenser is a polarisation current instead of being a dielectric current.—On the depolarisation of mercury and platinum electrodes, by K. R. Klein. Large and small electrodes dipped into various acid and salt solutions, and the course of their polarisation by a known E.M.F. and their subsequent depolarisation, was investigated by means of a capillary electrometer of negligible capacity. It was found that the rate of depolarisation was nearly independent of the area of the electrode and of the nature of the solution, but was much accelerated by heat and by the presence of a salt composed of the electrode metal as a base, and the acid of the electrolyte.—An electro-chemical method of converting alternating into direct currents, by L. Graetz. Cells in which aluminium forms the anode do not transmit currents having a voltage below 22. Alternating currents may therefore be converted into intermittent currents by means of a battery of such aluminium cells. The author describes an arrangement for obtaining a direct pulsating current by the same means The apparatus forms a convenient "rectifier."—Researches on lampblack, by J. Stark. The specific gravity of solid lampblack is forty-three times that of lampblack as deposited. One cc. contains 1,270,000 million particles of lamp black. The author obtained polished surfaces of lampblack, and proved that as regards elliptic polarisation they occupy a place intermediate between transparent substances and metals.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 12.—Mr. G. Johnstone Stoney, Vice-President, in the chair.—Mr. J. Rose-Innes read a paper on the isothermals of ether. The well-known generalisations of Boyle and Gay-Lussac with regard to the pressure, volume, and temperature relations of gases, were examined by Ramsay and Young, who deduced the law $p = bt - a$, *i.e.* that pressure is a linear function of temperature, at constant volume, where b and a are functions of volume only. It yet remains to discover the form of these two functions b and a. The author finds b and a for a large number of volumes, and from them devises an empirical formula. As a preliminary step he examines whether any single algebraical expression can represent the case, so as to determine the probability of discontinuity. For this purpose a graphic method is applied. By plotting $(av^2)^{-1}$, against $v^{-\frac{1}{3}}$, a curve is obtained of "cusp" shape. The point of the cusp occurs very near critical volume, it suggests discontinuity in the slope of $(av^2)^{-1}$. The author concludes that there is extremely rapid change of behaviour of the gas at this point. Again, it is known that the temperature at which pressure is accurately given by the laws of a perfect gas at a particular volume, is constant for large volumes until critical volume is approached. The author observes that at the critical volume this temperature diminishes somewhat from its value for large volumes. These conclusions were embodied in a previous paper, and an algebraical expression for pressure in terms of temperature and volume were then given for isopentane. In the present paper the author investigates a similar formula for ether. Prof. Ramsay said that experimental errors might account for some of the lack of agreement between proposed formulæ and direct observation of the behaviour of gases. Isopentane was probably a better-investigated body than ether, for it was simpler. Ether tended to form complex molecular groupings, but isopentane was probably a mono-molecular liquid. Prof. Perry did not quite agree with the author's conclusions. It was necessary to distinguish between a formula founded on a physical hypothesis, and a mere empirical formula. The author had assumed that the Ramsay and Young formula was very exact, its originators did not put it forward as being infinitely exact. Probably the best test for such a formula as that under discussion would be derived from some thermo-dynamical conclusion deduced from it. The Rose-Innes formula, with five constants

and implying discontinuity, was to be distrusted, for there was no such thing as discontinuity in the problem. In any case, an empirical formula should have a very simple form. Mr. Rose-Innes admitted that a formula founded on sound hypothesis was to be preferred to empirical expressions. But mathematicians had not yet provided an hypothesis applicable to a substance whose molecular arrangement was so complicated as that of ether. Mathematicians must, therefore, improve their methods before working formulæ could be deduced from their hypotheses. The use of an empirical formula with five constants was justified by Kepler for the planetary orbits. Kepler used that formula with no other justification than his experience that an ellipse fitted his observations better than a circle. Similar instances might be cited from recent work on the theory of solution, and osmotics. Mr. Johnstone Stoney was disposed to look for a mathematical cause for the cusp; it was improbable that the physical change was so abrupt as that represented graphically by the author. The question might be tested by plotting the two curves $y = v^{-\frac{1}{3}}$ and $y = a v^2$, and by observing whether these also suggested discontinuity.—Mr. W. L. Waters then read a paper on the variations in the E.M.F. of the H-form of Clark cells with temperature. The authors, Messrs. F. S. Spiers, F. Twyman, and W. L. Waters, have investigated how nearly the true E.M.F. of Clark cells can be computed at different temperatures by applying the ordinary temperature correction. As a standard, two cells of the Muirhead type are employed. The four cells under test could be put through cycles of temperature in a special heating bath, containing oil circulated by a centrifugal pumping vane. E.M.F.s were determined by a potentiometer method, and a careful study was made of the "lag" of E.M.F. behind temperature. The results are given in the form of curves. It is shown that "lag," in the H-form of cell, is less than in the "Board of Trade" form. Under ordinary conditions, when the rate of variation of temperature is less than 2° C. per hour, by applying temperature-corrections the true E.M.F. of the H-form can be found to within a ten-thousandth of a volt. In this respect there is little to choose between the H-form and the "Muirhead" cell. Mr. W. R. Cooper thought the authors did not express the case clearly. The E.M.F. of the "Board of Trade" cell could not, with reason, be itself stated within 1 per cent. But in some cases when, for instance, cells were used differentially, greater accuracy might be required, as, for instance, when a constant source of E.M.F. was being compared with the variations of another source. Here it might be necessary to know the "lag." He would like to know with what degree of accuracy the E.M.F. of the standard cell was determined by the authors. The lag that occurred in the "Board of Trade" cell was probably due to diffusion, crystallisation, and solution.—Mr. Waters said the E.M.F. of the standard was measured by a Kelvin balance to one in ten-thousand.

Entomological Society, November 3.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. Selwyn Image was elected a Fellow of the Society.—Mr. J. J. Walker exhibited specimens of *Anisolabis annulipes*, Luc., an introduced species of earwig taken among bones at the chemical works at Queenborough, and of *Brachysomus hirtus*, Boh., a rare weevil, taken among dead leaves at Chatham.—Mr. Janson exhibited a variety of *Melanargia galatea* of a clear yellowish cream colour, without trace of the usual black markings. It was captured between Dover and Walmer in 1843, and was still in very perfect condition.—Lord Dormer showed a remarkable openwork cocoon of an unknown Japanese moth, constructed from the larval hairs.—Mr. Jacoby exhibited fine examples of both sexes of the Australian Hepialids, *Charagria ramsayi*, *C. splendens* and *Hepialus daphnandri*.—Mrs. Nicholl exhibited a selection from the butterflies collected by her this year, in June and July, in the Albarracin Mountains in Aragon, containing several additions to the list of the district published in Madrid by Don Zapater and Herr Max Korb. The species of greatest interest were *Erebia zapateri*, Oberth., *Cœnonympha iphioides*, Staud., *Satyrus prieuri*, Pier., and its fulvous ♀ var. *uhagoni*, which was observed to be much more attractive to the males than the normal form was; *Argynnis hecate*, Esp., and *Parnassius apollo*, L., of which a female variety occurred with red-centred ocelli on the upperside of the forewing.—The Rev. H. S. Gorham showed examples of the following rare beetles from the New Forest: *Notiophilus rufipes*, *Velleius dilatatus*, *Trichonyx sulcicollis*, and *Lytta vesicatoria*.—Mr. Tutt showed a series of Noctuæ, taken at Romford by the Rev. W. Claxton, all of aberrant form; and for Mr. J. Merrin a specimen of *Aglais urticæ* with a silvery costal spot on the underside of the forewings, a series of *Melitæa aurinia*, and an example of *Syrichthus malvæ*, ab. *taras*, taken near Gloucester.—Mr. Kirkaldy exhibited a complete series of species of the genus *Notonecta*, L., specimens of the larva and imago of the very rare *Deinostoma dilatatum*, Say., from Arizona, and specimens of *Antipalocoris marshalli*, Scott, from Ceylon, which was previously recorded from Corsica alone.—Papers were communicated by the President on new or little-known species of African butterflies, and by Mr. E. Meyrick on new Lepidoptera from Australia and New Zealand.

CAMBRIDGE.

Philosophical Society, November 8.—The following communications were made:—On a method of demonstrating assimilation in green plants, by Mr. F. Darwin, President. Farmer has shown that the protoplasm ceases to circulate in an Elodea leaf subjected to a stream of hydrogen and kept in the dark; also that if the preparation is illuminated the circulation begins again. The cessation of the circulation depends on the protoplasm being deprived of oxygen, the reappearance of the movement is a consequence of the fresh supply of oxygen yield by the chloroplasts in light. The experiment can be more simply performed by mounting in water two or three Elodea leaves under a single cover-glass, and sealing the preparation with melted wax and paraffin. The leaves if kept in the dark begin after a few hours to suffer for want of oxygen, and after six or seven hours the protoplasm ceases to circulate. The movement may be restored by exposing the preparations to sunlight or to incandescent gas flame. Thus a demonstration, in its way as interesting as Engelmann's bacterial method, may be very simply performed.—Artificial cultures of *Stereum*, a timber-destroying fungus, by Prof. Marshall Ward.—On *Encephalartos ghellinckii*, Lem., a rare Cycad, by Mr. A. C. Seward. The author gave a short description of a plant of *Encephalartos ghellinckii*, Lem., which had been obtained by Mr. Lynch, of the Botanic Gardens, from Messrs. Saunders, of St. Albans. This species differs in the form of the frond from the better-known examples of the South African Cycadean genus *Encephalartos*, and presents certain features which are of importance from a palæobotanical point of view.

MANCHESTER.

Literary and Philosophical Society, November 2.—Mr. J. Cosmo Melvill, President, in the chair.—Prof. Boyd Dawkins, F.R.S., exhibited a section of a spruce trunk which had been completely hollowed out by a polysporous fungus. The resinous pine-knots, however, are left entire, radiating from the centre. He also pointed out that similar pine-knots (which he examined in the museum at Basle) found in the interglacial deposit of Darnten, and considered by Profs. Rütimeyer and Schwendauer to be the remains of old basket-work or wattle-work, and to prove the existence of interglacial man, are merely the result of the nature decay of the wood, and are not artificial. He also showed, under the microscope, a section of Fardel coal, showing a resinous stem or knot from a carboniferous plant, the rest of which has gone to form the black substance of the coal. Prof. F. E. Weiss made some remarks on the exhibit, attributing the destructive action to the fungus *Trametes pini*, and explained how the fungus attacked the centre of the tree, making its way in through the decayed core of broken branches.—Prof. Weiss then exhibited a specimen of *Plowrightia morbosa*, the black-knot, on a branch of cherry collected in Canada, where it has been the cause of considerable destruction of cherry-trees. He also exhibited the fructifications of *Peziza æruginosa*, the green-rot of the oak. The fructifications of this fungus, which are rarely met with, were collected at New Abbey, near Dumfries. A discussion followed, which also turned on the subject of the colouring-matter of fungi.—Prof. H. B. Dixon, F.R.S., exhibited and remarked upon a number of lantern photographs of explosion-flames.

PARIS.

Academy of Sciences, November 8.—M. A. Chatin in the chair.—On the influence of hygroscopic substances upon the combination of hydrogen and oxygen, by M. Berthelot. The hygroscopic substances chosen were hydrogen chloride, boron fluoride, and sulphurous anhydride as giving homogeneous systems for liquids, concentrated sulphuric acid; for solids, phosphorus pentoxide, baryta, quick-lime, and potassium hydroxide. Of these the three gases were found to be without appreciable effect in accelerating the reaction; with sulphuric acid, the

hydrogen alone disappeared at 280°, owing to its reacting with the acid. In the case where phosphorus pentoxide was present, the rate of combination was of the same order of magnitude as when the mixture was heated alone. The conclusion is drawn that there is no equilibrium corresponding to the vapour pressure of the water produced, but that the reaction, although very slow, is unlimited.—On an explanation applicable to the phenomena of Faraday and of Zeeman, by M. Henri Becquerel. Starting from the hypothesis that in a magnetic field the ether possesses a vortex-movement of given period, θ, the conclusion is drawn that in the Zeeman phenomenon the variation of the wave-length ought to be proportional to the square of the wave-length. The value of the reciprocal of θ is calculated both from the Zeeman and Faraday effects, the numbers for air showing a good agreement in the two cases.—Study of the oysters of Cette, from the point of view of pathogenic micro-organisms, by MM. Ad. Sabatier, A. Ducamp, and J. M. Petit. No pathogenic organisms could be found in oysters after exposure for some time to water containing sewage. Even when cultures of the typhoid and *Coli communis* bacilli were injected into living oysters, no trace of either could be detected after four days in sea water. The authors conclude from these experiments that there is no ground for considering oysters as one of the causes of typhoid fever.—The Perpetual Secretary announced to the Academy the loss sustained by science by the death of M. Scheering.—Observations on the Perrine comet (October 1897) made at the Observatory of Algiers, by MM Rambaud and Sy.—On the general theory of functions of real variables, by M. R. Baire.—On the potential of the double layer, by M. A. Liapounoff.—On the mechanism of rotatory magnetic polarisation, by M. André Broca.—On the variation of energy in isothermal transformations; electric energy, by M. H. Pellat.—The dissemination of the X-rays, by M. Abel Buguet. By the use of protecting leaden screens, in cases where a long exposure is required, a much clearer photograph is obtained.—On the molecular volumes and densities of gases in general at all temperatures and mean pressures, by M. A. Leduc.—Table of the elements, arranged with the atomic weights in multiple proportions, by M. H. Wilde.—On some new lines in the spectra of oxygen and of thallium, by M. H. Wilde.—On the action of nitric acid upon tin, by M. R. Engel.—Estimation of phenylhydrazine, by M. H. Causse. The method proposed is based upon the reduction by the phenylhydrazine of arsenic to arsenious acid, and the iodometric estimation of the latter.—New combinations of phenylhydrazine with mineral salts, by M. J. Moitessier. The salts described are compounds of phenylhydrazine with the chlorides and sulphates of nickel and cobalt, and cobalt bromide. They contain more phenylhydrazine than the series previously described.—Biological preparation of levulose from mannite, by MM Camille Vincent and Delachanal. The ferment of sorbose, developing in a solution containing mannite, oxidises the latter to levulose.—On some halogen derivatives of methyl-phenyl ketone, by M. A. Collet. The preparation and properties of

$C_6H_4Cl.CO.CH_2Cl$ [1 : 4], $C_6H_4Br.CO.CH_2Cl$ [1 : 4],
$C_6H_4Cl.CO.CH_2Br$ [1 : 4], and $C_6H_4Br.CO.CH_2Br$ [1 : 4]

are described. — On caroubinose and *d*-mannose, by M. Alberda van Ekenstein. The sugar described as new by M. J. Effront (August 2, 1897), obtained from the grains of *Ceratonia siliqua*, is identical with *d* mannose.—Vegetation with and without argon, by M. Th. Schlœsing, jun. No difference could be observed in the growth of the plants in the two cases, and no measurable amount of argon was absorbed.—On Strongylosis observed at the Agricultural School at Grignon, by M. Ch. Julien.—On the production of gum in the Sterculiaceæ, by M. Louis Mangin.—On the periods of development of the black rot in the south-east of France, by M. Joseph Perraud.—On the diseases of the bulbs of *Crocus sativus*, L., by M. E. Roze.—Researches on the formation of oil reserves in seeds and fruits, by M. C. Gerber.—On the absorption of carbon monoxide by the blood of a living mammal, by M. N. Gréhant. The experiments showed that for air containing 1/6000th of its volume of carbon monoxide or less, the volume absorbed by 100 c.c. of blood was proportional to the time. For stronger mixtures (·001) a limit appeared to be reached after about three hours.—On the histoiogical modifications of nerve cells in a state of fatigue, by M. Ch. A. Pugnat. Fatigue in the nerve cells is accompanied by a diminution in volume of the cellular body and the nucleus, and by the disappearance of the chromatic substance of the protoplasm.—Intermediate forms in cartilaginous tissue, by M. Joannes Chatin.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—Account of a Comparison of Magnetic Instruments at Kew Observatory: C. Chree, F.R.S.—Note on the Influence of very Low Temperatures on the Germinative Power of Seeds: H. T. Brown, F.R.S., and F. Escombe.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. II. On *Spencerites*, a New Genus of Lycopodiaceous Cones from the Coal Measures, founded on the *Lepidodendron Spencerí* of Williamson: D. H. Scott, F.R.S.—The Histology of the Cell-wall, with special reference to the Mode of Connection of Cells: W. Gardiner, F.R.S.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K Pearson, F.R.S., and L. N. G. Filon.—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.

LINNEAN SOCIETY, at 8.—On *Pontobothos manaarensis*: Prof. A. Dendy.—On Haddonia, a New Genus of Foraminifera: F. Chapman.

CHEMICAL SOCIETY, at 8.—On the Decomposition of Camphoric Acid by Fusion with Potash or Soda: Dr. A. W. Crossley and W. H. Perkin, jun., F.R.S.—Experiments on the Synthesis of Camphoric Acid: W. H. Bentley and W. H. Perkin, jun., F.R.S.—The Action of Magnesium on Cupric Sulphate Solution: Dr. Frank Clowes and R. M. Caven.—Properties and Relationships of Di-hydroxytartaric Acid: H. J. Horstman Fenton.

CAMERA CLUB, at 8.15.—Seismograms and Telegrams: Prof. Milne, F.R.S.

MONDAY, NOVEMBER 22.

CAMERA CLUB, at 8.15.—Electric Waves, illustrated by Telegraphy without Wires: A. Campbell.

TUESDAY, NOVEMBER 23.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Central Station Electric Coal Mining Plant in Pennsylvania: W. S. Gresley.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photographs of the Optical Projections in Space produced by the Aerial Graphoscope; Probable Projection of Lightning Flashes, illustrated by Experiments and Photographs: Eric Stuart Bruce.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

LEIGH BROWNE TRUST AND THE HUMANITARIAN LEAGUE (St. Martin's Town Hall, W.C.), at 8.—The Germ Theory and its Fallacies: Dr. Campbell Black.

WEDNESDAY, NOVEMBER 24.

SOCIETY OF ARTS, at 8.—Progress of Metallurgy and Metal Mining in America during the last Half-Century: Prof. James Douglas.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein. (Continuation of Discussion.)

CAMERA CLUB, at 8.15.—Photographic Action Writ Large: a Kurveylinear Conversation on Corn: Prof. Armstrong, F.R.S.

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