THURSDAY, DECEMBER 30, 1897.

## MOTIVE POWER AND GEARING.

*Motive Power and Gearing for Electrical Machinery.* By E. Tremlett Carter, C.E., M.I.E.E., &c. Pp. xxii + 620. (London: *The Electrician* Printing and Publishing Company, Ltd.)

MR. CARTER has written a very interesting and very useful book on a subject of much importance for electrical engineers. The needs of electrical practice have had a great effect in stimulating the invention of quick-running steam engines, the improvement of gas engines, and the discovery of modes of transmitting power from the driving machine to the driven which did not formerly exist. An electrical engineer is all the better electrical engineer for being also a good mechanical engineer; but as he must master (if he is to be anything but the veriest rule-of-thumb mechanic) in the course of his training in the class-room and the workshop, a very considerable body of more purely electrical knowledge and practice, and, over and above, acquire some knowledge and experience in mechanical matters, the latter is the point in which, when starting on his practical career, he is apt to be most deficient.

Of course, for making all these things realities to a man, there is no education for the engineer like that of the workshop, provided his theoretical training in the principles of the scientific work he is to do (for scientific it ought always to be, or he is no true engineer), is carried on at the same time, just as for the scientific study of physical science there is no training like that of the laboratory carried on parallel with systematic discussion of physical theory and experiment in the lecture-room.

The electrical engineer, as we have observed, however, if properly trained, has always an inquiring spirit, and an observing eye, and an adaptability of self to circumstances, which enable him as he goes on in his work, and comes into contact with the considerable diversity of machinery which it is his lot to encounter, to gradually become a mechanical engineer of great resource and skill so far, at any rate, as his own department of work is concerned.

A book like Mr. Carter's, studied in connection with workshop practice by a capable man, or kept on the shelf in the dynamo room to be read and consulted when time or the requirements of work present opportunity, cannot but be of great service. The topics dealt with are many and various, and an enumeration of them would more than occupy all the space at our disposal, though it would bring out very clearly how great is the range of mechanical question and device with which the electrical engineer is now concerned.

The first chapter deals with fundamental principles, such as motive power, work, energy and its sources, inertia, waste power and useful power, load and load diagrams, dynamometry (more properly ergometry), and storage of energy. The order of treatment differs somewhat from that which in a complete discussion of such subjects would be regarded as logical, but it is, so far as it goes, quite scientific, though the ideas referred to are occasionally so general as to require a good deal of special discussion and elucidation, which of course must be obtained elsewhere.

In the discussion of reciprocating (or simple harmonic) motion, it would have been well to insert besides the statement that the numerical ratio of the acceleration to the displacement is a constant, that the value of this ratio is $4\pi^2/T^2$ where T is the period of the motion. This is a simple rule which is of real service in dealing with vibrations. The phrase "elastic forces of inertia" seems a little strange to the pure physicist; but of course what the author is insisting on, is the give and take action of a body, which in consequence of its inertia stores up energy in an accession of speed, and restores it again when the speed is diminished.

A beginning is made in this chapter of the important subject of the measurement of power. One or two forms of brake and of transmission dynamometer are described, and the general principles discussed, the further treatment being left till the systematic application of tests comes under review.

In this chapter also, it ought to be mentioned, the author treats of economy of design. Lord Kelvin's law of economy, though acted on to some extent, is not yet, it is to be feared, fully appreciated and acted on. It says really that improvement cannot be economically carried beyond the point at which the proper annual charge for the capital invested in an improvement of plant, is just equal to the annual saving effected by making it. Here is a point, of course, at which increase in the cost of materials and labour retards, and diminution in the same facilitates, improvement in design.

After a statement of the problem to be solved, which he puts in the form, "What are the best provisions which may be made for utilising the available energy for the performance of useful work and the production of a paying revenue?" the author proceeds to deal with the steam engine. This forms Part ii. of the work, and is treated under the headings: Fuels, thermodynamics, principles, steam, furnaces and boilers, theory and action of the steam engine, steam engine details, some typical steam engines, steam engine driving, the steam engine in relation to electric power, the management of steam plant.

After this enumeration of chapters, it will not appear surprising that this part comprises more than half the book by some twenty-two pages. All the chapters seem to us full of practical information, and of great value to electrical engineers. The sketch of thermodynamics given is perhaps that which is most directly open to criticism, not so much on account of what is included as of what is left out. There are, however, one or two points on which we would offer one or two slight remarks. First it would be well always, if the phrase "perfect gas" is to be used, to offer some direct definition of its meaning. Mr. Carter does so in his p. 73. Practically what he defines as a perfect gas is one which, under all conditions, fulfils the characteristic equation $PV/T = \text{constant}$. But in the definition of T there seems a little looseness. Thus it is stated (same page), "taking the zero on the Fahrenheit scale as the standard it was found by Charles, that all gases expand 1/460 of their volume at this temperature when raised from any temperature to a temperature 1° F. higher." Then from this increase of volume for each degree of the F. scale it is inferred that the absolute zero is 460° F. below the ordinary zero. Logically this process is deficient in that it presupposes a known Fahrenheit scale; and there were just as many perfectly exact Fahrenheit scales as there were previously existing exactly made Fahrenheit thermometers. Our impression is that the law of Charles or Gay-Lussac expressed the fact that the different gases experimented on, all expanded by nearly the same fraction of their volume at the temperature of melting ice on being raised under constant pressure from that temperature to the "boiling point" of water. Then *this* expansion (from $v_0$ to $v_{100}$ say) obtained accurately for any one gas enables $t°$ C. to be *defined* for *that* gas as thermometric substance as that temperature for which the volume of the gas under constant pressure is $v_0 + t(v_{100} - v_0)/100$, and so also for the Fahrenheit scale. Taking air, we get by this definition the air thermometer scale, which, having its own independent definition, can be used as a standard of comparison for other thermometric scales.

From this we get the absolute zero on this gas thermometer scale as that for which $t = -100\,v_0/(v_{100} - v_0)$ that is for which the volume of the gas is zero. Fulfilment of Boyle's law, if it exists, gives agreement of the similarly, but independently, defined constant volume scale for the same gas with the constant pressure scale. Thus we get an independent scale for each gas for which accurate experimental data are available, and the *numerical reckoning* of the absolute zero of temperature will not be necessarily the same for all. We say this with Mr. Carter's note on p. 107 in view. We believe that a perfect gas is best defined as one which obeys Boyle's law at all pressures and temperatures, and gives a constant pressure scale agreeing with the only properly absolute scale of temperature, that of Lord Kelvin, or, which comes to the same thing, as a gas which, besides fulfilling Boyle's law, has an invariable ratio of specific heats.

The second law of thermodynamics is hardly that given on p. 106, which is really the so-called "axiom" on which Lord Kelvin based the second law. The law itself is most shortly expressed by the equation $\int dq/t = 0$, where $t$ is absolute temperature, $dq$ a quantity of heat taken in (or given out) at temperature $t$, and the integral is taken round a reversible cycle. If $t_0$ be the lowest available temperature, the positive value which $-t_0\int dq/t$ has for every non-reversible cycle is Lord Kelvin's expression for the heat dissipated in the cycle.

We are rather disappointed that no treatment, *e.g.* the beautiful graphical treatment given by Maxwell, is included of the thermodynamics of change of state. By means of the Protean fundamental parallelogram of the Carnot cycle, the whole of the essential part of thermodynamics can be given in two or three pages. A statement from this point of view of the information which thermodynamic theory gives as to the density of saturated steam would not have been inappropriate here.

The account of furnaces and boilers and of steam engines generally seems very full and complete, but a full review of it is a thing to be undertaken only by an expert in these matters. No one, however, who takes an interest in engineering methods and results, and nothing can be more valuable for the physicist than their study, can fail to be struck with the fulness of the information given by Mr. Carter.

In Part iii. gas and oil engines are discussed, and we have, after a chapter on gaseous and liquid fuel, the Otto cycle, and engines working on this cycle are fully described. This, to us, is perhaps the most interesting part of the book. Prime-movers of this description have advanced immensely during the last ten or twelve years, and the lot of those who have to use them is cast in much pleasanter places. We have a lively recollection of having to toil with five or six enthusiastic laboratory students turning the fly-wheel for nearly half an hour at a time trying to get a large gas engine started. This and other difficulties, and the continual setting to rights which the engine required, would have tried the patience of a saint, and certainly were too much for ordinary mortals.

In Part iv. water motors and turbines generally are discussed, in Part v. gearing is dealt with, and in Part vi. we have a most valuable account of types of power stations.

The book, it ought to be mentioned, is one of several excellent practical works that have appeared by instalments in the *Electrician*. It is very thoroughly illustrated with excellent drawings: engines of all kinds, central power stations, details of machinery, such as valve gear, governors, injectors, &c. Some of these might perhaps have been worked up better, but most are good, and all are thoroughly business-like and intelligible. We regret that we have not space to deal with the work more adequately; but as it is, in fact, a collection of some three or four separate treatises of great value, any attempt to fully review it here is impossible.

We have nothing but congratulation for the author on his work. Electrical engineers are deeply in his debt.

A. GRAY.

## A PIONEER OF MEDICINE.

*Masters of Medicine. John Hunter, Man of Science and Surgeon.* By Stephen Paget, with an introduction by Sir James Paget. 8vo. Pp. 272, with a frontispiece. (London: T. Fisher Unwin, 1897.)

MR. FISHER UNWIN has undertaken to publish a series of volumes dealing with the life and works of the great scientific men who have brought medicine and the allied sciences to their present state of perfection. The object of the series, which is under the general editorship of Mr. Ernest Hart, editor of the *British Medical Journal*, is to set before unprofessional readers a plain account of the lives and fortunes of the "Masters of Medicine," with such a survey of their work as may be necessary to show wherein they excelled.

John Hunter lends himself particularly to this method of treatment. Living only a hundred years ago, the founder of a great school of thought, the hero of a hundred orations by the most eminent surgical minds of the century, there exists plenty of material from which to construct a most readable biography. His life, indeed, has often been written but not always judiciously, for it is only of late years that the critical spirit, which has reduced the writing of history to a science, has begun to pervade the historians of medicine. Mr. Paget has performed his work excellently, for he has consulted original authorities and has availed himself, by the kindness of Miss Hunter-Baillie, of such documents belonging to the Hunter family as are now in her possession. Fresh light is thus thrown upon some of the more obscure points in Hunter's career, whilst the charming personality of Mrs. Hunter, who selected the words for Haydn's Creation, is brought into bolder relief.

John Hunter, the founder of pathology, or the science which deals with the causes and progress of disease, was one of the younger members of a very remarkable band of pioneers in medicine who were born within a few miles of each other in a remote country district of Scotland, and who flourished in the middle of the last century. First in seniority was Smellie, of Lanark, the great man-midwife; then Cullen, sometime professor of medicine in Edinburgh, born at Hamilton; after him came William Hunter, in some respects greater even than John, his youngest brother; and finally Matthew Baillie, nephew of the Hunters, and the most worthy disciple of his uncles. Smollett, too, was the intimate friend of Smellie, and so must have known the Hunters. It would be of extreme interest to know the factors which led to the production of such extraordinary talent in so circumscribed an area and for so limited a period. In the Hunter family no less than three sons of the ten children were extraordinarily gifted, and in each case their genius was directed towards medical science. That the genius was innate is clearly shown by the fact that John Hunter instantly became an accomplished anatomist, and that although he was an original thinker of the highest power, he was in many respects illiterate, and always had the greatest difficulty in expressing his thoughts in words. Beginning with nothing, John Hunter, after many years of struggle, achieved a foremost place amongst the surgeons of London. But it was by his teaching, rather than by his clinical powers, that he gained his reputation. Edward Jenner, in England, the discoverer of vaccination, and Dr. Physick, who lived to become the veteran exponent of his master's teaching in America, were amongst his house pupils, whilst all the foremost surgeons of the next generation had attended his lectures—lectures which cost his hearers but tenpence a-piece, as Mr. Paget points out, for they were near a hundred in number, the honorarium for the course being four guineas. Yet the lectures were of the most magnificent kind, for they comprehended the whole circle of the sciences round surgery. They were made at a great cost to Hunter, for his brother-in-law, (Sir) Everard Home says of them:

"Giving lectures was always particularly unpleasant to him; so that the desire of submitting his opinions to the world, and learning their general estimation, was scarcely sufficient to overcome his natural dislike to speaking in public. He never gave the first lecture of his course without taking thirty drops of laudanum to take off the effects of his uneasiness. He was so diffident of himself that he trusted nothing to memory, and made me draw up a short abstract of each lecture, which he read on the following evening as a recapitulation to connect the subject in the minds of the students."

It is no wonder, therefore, that the toils of his practice, the cares attending the amassing of the nucleus of the magnificent museum now housed in Lincoln's Inn Fields, and the labours of teaching, early overweighted a body by no means strong. He suffered from angina pectoris for many years before his death, and was wont to say that his life was at the mercy of any rascal who chose to irritate him, and he was very irritable. He died suddenly at St. George's Hospital, October 16, 1793, on the same day, and perhaps at the same hour, that the unfortunate Marie Antoinette, Queen of France, was beheaded in Paris. He was buried in the vault of St. Martin's-in-the-Fields, whence the pious care of Frank Buckland rescued his remains in 1859, and they were re-interred in Westminster Abbey.

Mr. Paget has performed his task most excellently, and if the present volume is to be taken as a standard for the series the sale should be large. Not only is the book well and pleasantly written, abounding in anecdote, but it is most tastefully produced, so that the paper, the print, the binding, and the reproduction of a part of Sir Joshua Reynolds' portrait of Hunter are in every way admirable.

## SELECTIONS FROM A DIARY.

*The Journals of Walter White, Assistant Secretary of the Royal Society.* With a preface by his brother, William White. Pp. vii + 285. (London: Chapman and Hall, Ltd., 1898.)

MOST of the Fellows of the Royal Society of more than twelve years' standing will retain a lively recollection of Mr. Walter White, whilom Assistant Secretary to the Society, and will look with interest into the present volume. Mr. White entered the service of the Royal Society in 1844, and in 1861 (not, as incorrectly stated in the preface, in 1853, "less than ten years") was appointed Assistant Secretary, which office he held until 1885. During this long period he had unusual opportunities of watching the inner working of the Society, and thus the development of scientific ideas and activities; and the reader of the diary of so shrewd and observant man as he was, would naturally expect to learn much. We are compelled to say at once that such expectations will not be fulfilled.

The first chapter, which contains entries in the diary up to the time of his attaining a post at the Royal Society, is interesting as showing how a man, brought up as a cabinet-maker, after pursuing diligently his trade for some years, by continued intellectual toil, bravely teaching himself, won his way, amid many discouraging circumstances, to a means of livelihood more congenial to his nature. It will probably surprise many of the Fellows of the Royal Society to learn that one whose great knowledge of languages and literature had often been of help to them, had spent so many of his earlier years at the joiner's bench.

The third chapter puts together a number of entries illustrating Mr. Walter White's intimacy with the late Lord Tennyson. From one of these entries we gather that it was a suggestion from Mr. Walter White which led the poet eventually to build a house at Haslemere.

The second and fourth chapters contain, together with other matters, entries relating to the Royal Society and science, the former chapter dealing with the period from 1844 to 1861, when Mr. White became Assistant Secretary; the latter with that from 1861 to 1884, the year before he ceased to hold office. The forty years which these two chapters cover were years in which science made remarkable strides, and years also during which important events took place within the Society. Mr. Walter White was literary rather than scientific in his leanings; still the records of the impressions made by the successive exposition of new scientific ideas upon one who listened to them in turn, near at hand, during so long a series of meetings of the Society could not fail to be interesting. We are told in the preface that the present volume is not the whole diary, but only selections from it. It is to be regretted that what has been published contains so little dealing with the weighty matters of science brought before the Society during the forty years, or with the effects produced by new ideas on those who were the first to listen to them. It is still more to be regretted that the selection has been so largely confined to matters which cannot justly be called by any other name than tittle-tattle and scandal. From his position Mr. Walter White was to a large extent a confidential servant of the Society. The Fellows were in the habit of talking to him freely, and often expressed themselves concerning scientific things and scientific persons in a familiar and unguarded manner. There could be no harm in Mr. Walter White writing down for his own delectation sayings which pleased him on account of their picturesque force, such as Mr. A.'s account of Dr. B.'s opinion about Prof. C.'s works and ways; but it is to be exceedingly regretted that Mr. William White should have thought it desirable to give publicity to gossiping statements, redeemed neither by wit nor by accuracy, the appearance of which can do little more than give pain to the living, or to the friends of the dead whom they concern. We hasten to add, lest the above remarks should excite curiosity, that the gossip in question will yield very little amusement where it does not give offence. We may add that the volume does not do justice to Mr. Walter White himself any more than it does to the leading men of science and the Royal Society; their conversation with him did not consist chiefly in finding fault with each other, nor was his chief delight in listening to them, and taking notes of their angry or idle words.

## OUR BOOK SHELF.

*Agricultural Chemistry.* By R. H. Adie, M.A., B.Sc., and T. B. Wood, M.A. 2 vols. Pp. ix + 280, and vii + 229. (London: Kegan Paul and Co., Ltd., 1897.)

IN the preface this is described as an elementary textbook of chemistry, designed for students beginning the study of agricultural science, and adopting as its method the teaching of the subject by experiment. The book demands some attention, as it is written by the teachers of agriculture in the University of Cambridge.

We are often told that the only right way of teaching chemistry is by leading the student to be himself the discoverer of chemical facts and laws by a series of experiments, observations, and inferences. This method is certainly excellent as an introduction to the science, but it becomes too cumbersome as the scholar proceeds, and the teacher soon finds himself making important statements of which no demonstration is forthcoming. Nor are all parts of the science best learnt by the exhibition of experiments. It is, indeed, easier to learn grammar as grammar, than to discover grammar for ourselves by the analysis of a language.

The first of these small volumes is intended as an introduction to general chemistry; the second deals with the subjects of soil and manures, with a briefer reference to the constituents of plants, and the analysis of foods.

It is difficult to tell in what manner the book is intended to be used. The details of the experiments are often so imperfectly described, that it would be impossible for a student to perform them without further directions. The preface states that the book is especially intended as an aid to teachers; but if the teacher is to follow the course marked out, he must clearly have a great deal of other information to fall back upon. One cannot, however, resist the conclusion that a great many of the experiments mentioned are not meant to be performed, but merely to be talked about.

We need hardly say that a good deal of correct teaching is given, but the errors and deficiencies are not a few. R. W.

*Notions générales sur l'Écorce terrestre.* Par M. le Prof. A. De Lapparent. 8vo. Pp. 156. (Paris: Masson et C^ie^., 1897.)

GEOLOGY can be made attractive enough by a good writer who divests the subject of those details which concern only the specialist. To learn the aims of the science and its main results are all that the general reader and the elementary student require; and it is well when, as in the present little work, a distinguished master is not only willing but able to produce such a sketch agreeably written as well as instructive. The subject is introduced in the course of six lessons, and the author, in the first place, deals with the early history of the globe, with seas and continents, and the external features of the earth in general. He passes on to consider various questions of physical geography, and the erosion of the land by rain, rivers, and sea. His remarks on the cutting away of river-courses so as in time to produce a *profil d'équilibre* are illustrated with reference to the Seine, which has excavated its channel almost to the lowest possible level throughout its main course. The method of accumulation of various sediments, and volcanic phenomena are next discussed. Upheavals and depressions and the sequence of rocks form the subjects of another lesson. Some account of the Paris Basin is given, and in conclusion there is a brief description of the principal geological formations. The work is illustrated by thirty-three figures of fossils, sections, and photographic reproductions. Among the fossils only the principal forms of life are indicated, such as a Sea-urchin from the Chalk, a Devonian Spirifer, Jurassic Ammonites, and a Fossil Bird. The student's mind is therefore not burdened with many names, but a perusal of the work will give him a clear general grasp of the principles and elements of geology. H. B. W.

*The Dawn of Civilization: Egypt and Chaldæa.* (Third edition.) By G. Maspero. Pp. xiv + 800. (London: S.P.C.K., 1897.)

THE third edition of "The Dawn of Civilization," the English translation of Prof. Maspero's "Les Origines," has just been issued. The three coloured photographic plates which were inserted in the second edition are here retained, while but few changes have been made in the text of the second edition of the work. The most considerable addition appears to be in the chapter dealing with the first Theban empire. Here the author gives a brief sketch of the conclusions that may be drawn from a study of the remains recently found by Prof. Petrie between Ballas and Naqâda. Towards the end of the sixth dynasty the Libyans, yielding to a migratory impulse, overran the western frontier and established themselves in Egypt, leaving a permanent record of their presence in the burying places and remains of villages which extend the whole length of the mountain chain from Siût to Gebelên. Prof. Maspero does not go so far as Prof. Petrie, who would regard the whole of the south of Egypt as having been wrested from the native kings by this "new race"; he does, however, conclude that these Libyan settlers were predominant throughout a considerable area on the left bank of the river, and that their influence was felt for more than a century. The pagination remains the same as that of the two earlier editions of the book.

*The Local Distribution of Electric Power in Workshops, &c.* By Ernest Kilburn Scott, A.I.E.E. Pp. 137 + viii. (London: Biggs and Co.)

THE advantages of electric transmission of power in factories and workshops are not so well known as they might be, or the electric driving of machinery would be more extensively adopted than it is. Wherever electric motors have been made to do duty in machine shops, complete success has been attained, but it is only in late years that engineers and proprietors of factories have learned to make use of electric driving to any great extent. Lately, however, this branch of electrical engineering has been coming to the front, and it promises to develop into the most important branch of electrical work, electric lighting not excepted.

The information brought together by Mr. Scott will show manufacturers what has been done, and what electric motors are capable of doing. The advantages of electric driving, both economically and commercially, are clearly pointed out, and detailed particulars of power required by various machines are given. The advantages and disadvantages of alternating currents from the point of view of power distribution in factories are discussed, and there are descriptions of the various points of a power installation, with examples of the most recent practice. The book is thus one which should be in the hands of all who are concerned with the applications of electricity to the machines and tools of workshops and factories.

*Memory and its Cultivation.* By F. W. Edridge-Green, M.D., F.R.C.S. (International Scientific Series.) Pp. 307. (London: Kegan Paul and Co., Ltd., 1897.)

DR. EDRIDGE-GREEN considers that the human mind is divisible into "ultimate faculties," a list of which he gives. Of these "ultimate faculties" some thirty-seven are assigned to this position with certainty. Dr. Green has no doubt whatever about their fitness to be considered "ultimate faculties," although amongst them are such qualities as Causality, Alimentiveness, and Inhabitiveness. Others there are, such as Vitativeness and Human Nature, whose position as ultimate faculties of the human mind is still *sub judice*. Dr. Green might, we think, have postponed the publication of this book until he had made up his mind about them. Part of the book is devoted to the description of a system of cultivating the memory; but there is the best possible evidence that either Dr. Green does not himself utilise this system, or the system is worthless. He would certainly never have published a work on psychology without acquainting himself with the present state of knowledge upon the subject. Yet he has forgotten the whole of his psychological studies as completely as if they had never existed. If his system were one for cultivating the art of forgetfulness, and were a perfect system, the result could not be more complete.

*Illusions and Hallucinations.* By Edmund Parish. Pp. xiv + 390. (London: Walter Scott, Ltd., 1897.)

THIS is a very thorough account of the subject, in fact it is, perhaps, for the series to which the book belongs, almost too thorough, and the general reader may find some difficulty in getting a clear account of the author's views out of the mass of detail. The conditions of fallacious perception are fully considered, and the general phenomena are referred to disturbed association. The author gives new definitions of illusion and hallucination, the former being supposed to depend on the suppression of certain processes which normally intervene between the immediate sensory change and the perception process, while hallucination is referred to forced association. These definitions have the advantage that they refer both phenomena to a common cause, *i.e.* to dissociation of centres normally acting together; but they are open to the objection that they are based on purely theoretical and uncertain views, and it would probably be better to retain the old definition depending on the existence or non-existence of an external stimulus while recognising that there is no hard and fast line between the two conditions. There are two interesting chapters on the results of the international census of waking hallucinations. The author brings forward much evidence that the real nature of the "waking state" in most cases was one of abnormal dissociation. He criticises adversely the evidence for telepathy derived from the census, which was regarded as valid by the authors of the English Report. He brings forward from the Report itself evidence against this conclusion, and in regard to the supposed positive evidence, he lays great stress on the importance of similarity of association of ideas in the two cases. Among many other interesting points, only one can be mentioned here, viz. the criticism of the view that the negative hallucinations of hypnotism depend on suggested inattention. The author points out that an object may be made by suggestion to appear smaller and smaller, till it finally disappears. In this case, according to the theory, a phenomenon due to concentration or special direction of attention would be suddenly replaced by one due to lack of attention.

*Transactions of the Rochdale Literary and Scientific Society.* Vol. v., 1896–97. Pp. 90 + xxii. (Rochdale: James Clegg, 1897.)

BY publishing the papers in this volume the Council of the Rochdale Literary and Scientific Society brings the work of the Society into prominence, and assists in making the objects of the meetings known to a wider circle. The volume is as interesting as its predecessors, and is a creditable addition to local literature and science. Among the papers contained in the volume is a chatty account of "Men and Manners in Manila," by Dr. A. Jefferson, an elementary description (with figures) of "Egyptian hieroglyphics, picture-writing, and the English alphabet," by Mr. C. Heape, a brief note on some graphite and flint implements found in a neolithic store near Rough Hill, by Mr. W. H. Sutcliffe, and a paper on the geological history of the Cephalopoda, by Mr. Charles Wardingley.

We see from the report that a number of other papers, not included in the present volume, were read before the Society during the nineteenth session, and several very instructive lectures were delivered. The Society, appears, indeed, to be a centre of light and leading in Rochdale.

*Les Constantes Physico-Chemiques.* By D. Sidersky. Pp. 207. (Paris: Gauthier-Villars et Fils. Masson and Cie.

M. SIDERSKY has already contributed a volume on polarisation and saccharimetry to the Aide-Mémoire series in which the present book appears. The constants herein described are dealt with in a similar manner; they include density, change of state, viscosity, capillarity, indices of refraction, calorimetry, and photometry. For each of these constants, the author briefly describes the most exact and convenient methods of determining them, and gives in tabular form the results of observations made on various substances. In the descriptions of methods of experimentation, preference is given to those which are actually used in practice outside the physical laboratory, so the book will be a real aid in technical work. Physicists and physical chemists will find the volume a handy epitome of methods and results.

*By Roadside and River: Gleanings from Nature's Fields.* By H. Mead Briggs. Pp. 204. (London: Elliot Stock, 1897.)

"THE hand of destiny has scattered broadcast through the land the seeds of hope, and yet how many of them all have reached the harvest of ambition." If we rightly understand the purport of these opening words of the preface, the author is expressing some anxiety as to the fate of his literary efforts, and wondering whether his work will be appreciated. We wonder also what becomes of the host of books like this one, well printed and daintily produced, but amorphous in structure, and having no particular aim. There are, we suppose, people who enjoy reading insipid remarks based upon casual observations of nature, and to their kind attention we commend this book. A scientific mind soon wearies of trying to pick out the slender threads of fact which meander through the mass of sentiment.

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Dugong.

IN the Hakluyt Society's last book, "The Christian Topography of Cosmas, an Egyptian Monk" (London, 1897), there are some interesting notices of "Indian Animals" with figures, copies of those in "the Florentine Codex"; which, in their turn, *may* have been "drawn by Cosmas himself (or under his direction)," according to an excellent modern critic.

In one passage Cosmas says "the flesh of the turtle, like mutton, is dark-coloured; that of the dolphin is like pork, but dark-coloured and rank; and that of the seal is, like pork, white and free from smell."

For reasons too long to give here, I suppose Cosmas' "seal" (phoke) to be the dugong (halicore), which is generally described as very eatable; but I cannot anywhere find its colour, as meat, described.

"Potted dugong" from Queensland was on the London market not long ago; and I tried it, once. It was much of the colour of potted tongue.

The figure is more like a conventional sea-horse than anything else, and cannot be relied on much. It is, perhaps, a little less unlike to a dugong than to a seal.

The confusion of dugongs with seals still exists amongst seamen; though, of course, dying out amongst officers.

W. F. SINCLAIR.

### Potato-Disease.

IN the "Life and Letters of Charles Darwin," Darwin writes as follows:—

"Mr. Torbitt's plan of overcoming the potato-disease seems to me by far the best which has ever been suggested. It consists, as you know from his printed letter, of rearing a vast number of seedlings from cross-fertilised parents, exposing them to infection, ruthlessly destroying all that suffer, saving those which resist best, and repeating the process in successive seminal generations" (vol. iii. p. 348).

Can any of your readers inform me whether the plan was ever carried out, and if so with what amount of success?

Newcastle-on-Tyne, December 11. G. W. BULMAN.

## THE PREVENTION AND CURE OF RINDERPEST.

IN the second fortnightly number for October of the *Agricultural Journal* of the Cape of Good Hope is given a long report of a Conference between the Hon. Mr. Faure, Minister for Agriculture, Mr. Hutcheon (C.V.S.), Dr. Turner, Dr. Edington and Dr. Kolle on the question of inoculation against rinderpest. This account is followed by the Resolution of Conference, by a letter from Dr. Edington and by one from Mr. Hutcheon, in the latter of which is given a review of the different methods of inoculation now used for the purpose of obtaining a certain degree of immunity against rinderpest in the cattle of South Africa. As so many different statements concerning the exact methods used at the Cape by Koch, by Edington, and by Turner and Kolle, and also by Messrs. Danyz and Bordet, have been promulgated, a summary of these various methods may be of interest.

In Koch's method of using the gall obtained from sick animals as a protection against rinderpest, the bile is taken from animals that have contracted the disease by natural infection. It was at first recommended that only green bile and bile free from blood should be used; later this recommendation was modified by Drs. Turner and Kolle, who say "that the difficulty of obtaining good bile has been much exaggerated. If the animals destined to produce immunising gall are injected with a small dose of really virulent blood, say 1 c.c., and are killed at the end of the sixth day of the fever, at least four out of five will give typically good galls, and the gall of the fifth will, in all probability, be fit for use. As a matter of fact, all galls which do not smell, and which are not absolutely red from the presence of a large quantity of blood, can be used without danger by Koch's process"; it is afterwards stated that those galls which have the highest specific gravity appear to possess the highest immunising power. It would appear, however, that the gall-produced immunity is only temporary, and that before long the animals again become susceptible to infection by rinderpest. Another of the great drawbacks to this method of inoculation is the fact that in certain cases the galls appear to contain septic organisms, which not only diminish the immunising power of the gall, but also in some instances seem to have set up a septic condition in the cattle injected.

Applying the method now in vogue in connection with the preservation of vaccine lymph, Dr. Edington added a quantity of glycerine to the gall with the object, first, of preserving for some time the gall in a pure condition, and, secondly, of killing any septic germs which might be present in the gall before it was drawn off from the gall-bladder of the infected animal. Of course it was necessary to use a somewhat larger quantity of this mixture in order to produce immunity. Dr. Edington injected from 15 to 25 c.c. into the subcutaneous tissue of the dewlap. Animals so protected when injected with small quantities of virulent blood, certainly appeared to take the disease in a milder form; in some cases this was accompanied by local reaction and by a rise in temperature, and wherever this occurred there was a marked degree of active and more lasting immunity conferred on the animal. When $\frac{1}{5}$th of a c.c. of virulent blood—that is, blood taken from an animal suffering from an acute attack of rinderpest—was injected, a local reaction was, in most instances, obtained, but in certain cases the preliminary temporary immunity was so slight, that the animal succumbed to the disease set up by the second injection. If, on the other hand, only $\frac{1}{10}$th of a c.c. was used, the local and constitutional reaction was not always obtained, and although a much smaller number of animals succumbed to the contracted disease, a much larger proportion remained susceptible to natural infection. In connection with this bile method, also, it must be pointed out that when the raw or unglycerinated gall was used as the protecting medium, a certain small proportion of cases contracted severe and even fatal attacks of rinderpest; though whether this was due to the gall itself or to the accidental contamination with virulent blood is not stated in the report, though we should imagine that this latter accident might be by no means uncommon.

Finally, there is the method based on the use of the "anti-bodies" found in the blood of salted cattle, *i.e.* cattle that have suffered from a severe attack of the disease, but have recovered. By injecting gradually increasing quantities of virulent blood into such animals, the anti-bodies appear in still larger proportions in the blood, and can then be used either in the form of a serum solution or as a defibrinated blood solution. This serum may be used to confer such a degree of passive immunity on the animal, that it either escapes the disease altogether, or contracts it in a much modified form; again, the serum may be used to cure an animal in which there is already a rise of temperature accompanied by other signs of a naturally acquired attack of rinderpest.

All these methods have now been used at the Cape, and it may be of some interest to our readers to learn what is the consensus of opinion as laid down in the Resolution of Conference. It is agreed "that inoculation with bile, either pure (Dr. Koch's) or glycerinated (Dr. Edington's), should not be adopted in any district in which it has not already been commenced, as more satisfactory and more permanent results are obtained from the use of serum, and the latter method can be more successfully applied in clean herds than in herds which have been previously inoculated with bile."

The "Conference" then arrive at the conclusion that it is better not to recommend that the inoculation with Koch's bile should be followed by an inoculation with virulent blood on the tenth day, as formerly recommended, as it is found that unless this blood inoculation is followed by a decided reaction—which occurs very rarely—the immunity already conferred by the bile is not increased. It is recommended, however, that in the case of dairy cattle which have already been inoculated with Koch's bile a second bile inoculation may be made, as this will confer a protection for several months, and at the same time will not interfere with the secretion of milk.

The glycerinated bile method should be followed on the tenth day by the inoculation of one-tenth of a c.c. of virulent blood; and although a second blood inoculation fourteen to seventeen days later increases the active immunity in certain cases, its use has been followed by considerable mortality, and the Conference, while not opposing a second inoculation of blood, does not recommend its universal adoption, as it is attended with considerable risk.

There appears to be a decided opinion that serum, when properly prepared, is superior to, and much more convenient for use than defibrinated blood, and its use is strongly recommended in preference to the latter when it can be obtained, though it is also recommended that a certain number of fortified salted cattle —*i.e.* immunised cattle—be sent to districts far removed from centres where serum is prepared, in order that defibrinated blood may be prepared in cases of sudden emergency.

It seems to be the general experience (as in other diseases in which the serum treatment is used) that in healthy herds the use of serum alone does not confer a very permanent immunity; it is therefore considered necessary, in infected districts, to infect healthy animals with rinderpest, and keep the attacks under control by means of the serum. This may be most safely and satisfactorily accomplished by injecting virulent blood subcutaneously on one side of the animal, and serum on the other. If necessary, *i.e.* if the disease takes too active a form, a fresh dose of serum will usually enable the animal to pull through the attack. For all practical purposes, however, it has been found that clean herds, in which there is no disease already, should not be inoculated with serum until the disease makes its appearance amongst them, or in their immediate neighbourhood. The whole of the animals should then be injected, after which, or simultaneously, they may be injected with virulent blood, or be kept in close continuous association with infected animals by kraaling them together every night. In this way the animals become salted or protected; under these conditions the immunity produced is active and of long duration, as opposed to the temporary and passive immunity that is conferred by serum when used alone, and perhaps also by bile. Where bile has already been inoculated, it is no use to inject serum and then virulent blood; for, as already mentioned, the immunity conferred by the bile varies very greatly in degree in different cases. Where such bile inoculation has been resorted to, the most satisfactory course for the owner to pursue is to keep a supply of serum by him and inject all cattle as soon as they are observed to be ill, or as soon as the thermometer indicates a rise of temperature. Where serum cannot be obtained, as already mentioned, the blood from salted cattle may be used. These salted cattle are usually fortified by injections of virulent blood, commencing with 10 c.c., and then going to 20, 50 and, lastly, 100 c.c. at intervals of ten days. Either serum or blood is injected in quantities of 100 or 200 c.c. into the animals suffering from the disease. This injection may be made subcutaneously, and not into the muscles, either behind the shoulder or into the dewlap.

It is, perhaps, too early to be dogmatic on the question of the best method of treating cattle for the prevention and cure of rinderpest, but when the exceedingly fatal nature of the disease is borne in mind, and when it is remembered that the disease is so markedly infective and fatal that whole herds are practically exterminated when once the disease is introduced (the objections that are brought forward against inoculation against anthrax, that the percentage mortality from inoculation is almost or quite as great as the percentage mortality from the disease itself not holding good in this case), it is not to be wondered at that the South African farmers received with enthusiasm any method which would preserve to them even a large percentage of their cattle, and that many of them were quite willing to run the risk of introducing rinderpest through the bile inoculation if they could only be sure that some 60 or 70 per cent. of the so infected animals would recover, and would then be protected to a certain degree against future attacks.

As Koch's bile method complied with such conditions it was undoubtedly a marked step forward, whilst it also made it possible to obtain salted cattle with which serum experiments might afterwards be carried out.

These serum experiments—showing that in serum the veterinary surgeon has in his hands a weapon by using which he is able to control the course, even of a severe attack of rinderpest—have given the farmers confidence enough to make them actually anxious to produce the disease under such conditions that they may keep it under control, and so salt their cattle artificially; thus rendering them immune for a considerable period against infection, even of the most virulent character.

With the vast agricultural and cattle-breeding interest at stake, we may anticipate that Koch's earlier experiments will, in the very near future, be improved upon, that South African cattle raisers and dealers will in the long run be enormously benefited, and that a source of wealth, which until a very short time ago was threatened with almost immediate extinction, will continue to be one of the principal resources of a great and flourishing colony.

## *LARGE REFRACTING AND REFLECTING TELESCOPES.*

THE Yerkes Observatory, which has recently been completed and inaugurated, contains in its instrumental equipment the largest refractor in the world, the diameter of the object-glass spanning 40 inches.

The late Mr. Alvan Clark, the constructor of the lens in question, expressed the hope that still larger apertures might be successfully made, but he pointed out that the effect of flexure in larger discs was to be mostly feared, although he felt that it might be perhaps possible to still further increase the aperture without endangering the performance of the objective. Being therefore apparently near the limit to which such large object-glasses can be successfully constructed and mounted, it is only quite natural that attention should be turned to the other form of telescope, namely the reflector, and inquire whether this type of instrument is restricted in the same way as the refractor, or whether it can step beyond these bounds and open up fields which would otherwise be lost to us.

Discussions as to the capabilities of these two types of telescopes have been very rife, and while some observers hold that the reflector is the instrument of the future, others again take the other side and advocate refractors. It is now generally conceded that for definition the refractor is the instrument *par excellence*, but for purposes where light-grasping power is the main requirement the reflector takes the first place. In the cases of very large apertures reflectors can be made of diameters far exceeding anything that can be attempted for refractors. A point of initial importance in large instruments is the question of the focal length of the object-glass or mirror, as the case may be, for on this factor depends the length of the telescope tube. Now if this be of considerable length, the telescope mounting and dome have to be of considerable proportions, rendering the instrument both expensive and subject to many possible errors. To retain the size of the aperture of the instrument and reduce the focal length is a natural means of overcoming this difficulty, and this has been attempted in many instruments. Such a reduction is, however, accompanied by several optical drawbacks which detract from the efficiency of the instruments.

In the case of reflectors of large aperture and very short focal length a most striking deficiency becomes apparent, and, curiously enough, this has practically been passed unnoticed until Prof. Schaeberle (*Astr. Journal*, vol. xviii. No. 413) quite recently brought attention to it. So large is this source of bad definition, that he refers to it as a "fundamental optical defect." How he came to alight on this source of blurring factor will be best gathered from the following brief extract in his own words.

"On a very favourable night, I recently had the opportunity of testing the great Crossley reflector of the Lick Observatory, and found the surface of the same to be a practically perfect paraboloid of revolution; but on examining certain celestial objects—Saturn among others—I was very much surprised to find that the instrument failed most signally to come up to expectations. While puzzling and pondering over the probable cause of the poor results given by what I knew to be a finely figured surface, it occurred to me to ascertain the exact amount of the error introduced in the form of the image, resulting from the well-known fact that the focal point is not at the centre of curvature of the parabolic mirror."

To understand the origin of this bad definition, one must imagine a small circular disc situated in the focal plane of the paraboloid of revolution, and concentric with the optical axis. Viewing this disc from different points on the surface of the mirror, it is obvious that it will appear circular only when the eye is in the optical axis, but in all other positions it will appear elliptical, the eccentricities of the ellipses becoming greater the further the eye is moved away from the optical axis. Further, the angular diameter of both axes of the disc will decrease as the eye moves away from the optical axis, in consequence of the increase in distance from the focal point. The result of such a source of error as this would be that if the rays from the components of a double star be reflected by the mirror, the linear distance between their focal images as formed from different areas along any radius of the mirror will vary from a minimum for the area on the optical axis to a maximum for that area furthest away. In the case of a planetary disc, there will be produced a blurring effect caused by the numerous images of different sizes overlapping one another.

Having investigated this source of error, Prof. Schaeberle made a comparison of the efficiency of the more prominent reflectors now in use. The result is of such interest, that we must refer to it at some length.

In the following table the blurring effect for each mirror is tabulated in the fourth column, the fifth and sixth columns representing the computed difference of angular diameters of the outer ring of Saturn and the solar or lunar disc based on the given ratio of diameters.

| Reflector | Diam. of mirror $= 2R_m$ | Focal length $= F$ | Max. ratio of diameters $= \frac{a}{r}$ | Diff. of angular diameters for the given ratio | | Limiting radius of field for best definition |
|---|---|---|---|---|---|---|
| | | | | Saturn's outer ring | Sun or moon | |
| | Feet | Feet | | ″ | ″ | ″ |
| Lord Rosse ... ... | 6·0 | 55·0 | 1·0033 | 0·13 | 6 | 15 |
| Common ... ... ... | 5·0 | 27·0 | 77 | 0·31 | 14 | 7 |
| Lassell ... ... ... | 4·0 | 37·0 | 22 | 0·09 | 5 | 22 |
| Melbourne ... ... | 4·0 | 28·0 | 39 | 0·16 | 7 | 13 |
| Paris ... ... ... ... | 3·9 | 23·4 | 51 | 0·20 | 9 | 9 |
| Crossley ... ... ... | 3·0 | 17·3 | 57 | 0·23 | 10 | 9 |
| Draper ... ... ... | 2·4 | 13·0 | 64 | 0·26 | 12 | 8 |
| Lassell ... ... ... | 2·0 | 20·0 | 19 | 0·08 | 3 | 25 |
| Roberts ... ... ... | 1·7 | 8·2 | 78 | 0·31 | 14 | 6 |
| Common ... ... ... | 1·7 | 3·7 | 404 | 1·62 | 73 | 1 |
| Schaeberle ... ... | 1·5 | 12·3 | 28 | 0·11 | 5 | 19 |
| Draper ... ... ... | 1·3 | 13·0 | 19 | 0·08 | 3 | 25 |
| Schaeberle ... ... | 1·0 | 3·7 | 141 | 0·56 | 25 | 4 |

The last column gives the values for the limiting radius of the field of view of best definition for each telescope, on the assumption that the radius of the field of measured distances with the optical axis as centre, does not exceed a value which would introduce an error of more than 0″·05. The most striking feature of this column is the smallness of the fields in the several cases mentioned which are not influenced by this error.

A glance down the fifth column brings out clearly the fact that the smaller the ratio of focal length to diameter of mirror, the larger the difference of angular diameter of the objects observed. Thus in the case of the Draper, Schaeberle, and the two Lassell instruments, where this ratio is comparatively large, about 9 : 1, the differences are small, while for the two Common mirrors and Schaeberle's 12-inch, where the mean ratio is approximately 4 : 1, the differences increase very rapidly.

Not only will this blurring effect, caused by these differences of angular diameters of the images, be notably increased as the focal length is decreased, but the greater diameter of the image, and therefore distance from the optical axis, will bring this defect more in evidence.

The main result of the investigation, summed up in a few words, is that large parabolic mirrors having a ratio of focal length to aperture less than fourteen to one are, as regards definition, "theoretically unfit for making observations of extreme delicacy." It may be mentioned that this defect does not mar the efficiency of such instruments for certain kinds of work, such as spectroscopic, bolometric, &c.

Thus it is gathered from Prof. Schaeberle's investigation that reflectors of large aperture must also be of correspondingly great focal length if the definition of the object to be observed is to be of the first order.

As refractors of large aperture are seldom made of such short focal lengths as are in question, it is unnecessary here to consider the effect of this source of bad definition.

Several interesting points with reference to the capabilities of large instruments have been brought prominently forward during the last few months, and may be appropriately referred to in this place. Thus Prof. Wadsworth (*Astronomical Journal*, vol. xviii. No. 414) has dealt with the efficiency of large refractors for visual observations of planetary details. He finds that from an optical point of view, it is a distinct advantage to increase the apertures of telescopes intended for visual use of planetary detail, such as fine linear markings, up to such a point where the atmospheric aberration will amount to about one-seventh or one-eighth period under the best conditions of observation. If this point be exceeded, then no advantage is obtained, the efficiency actually falling off; the tendency is for the faint lines under observation to be blotted out, instead of becoming more distinct. Indeed so sure is he of this, that he says the limit of efficient size is about reached between 30 and 35 inches, or the limit is very rapidly approached.

Another point of great importance *re* large apertures is that such telescopes cannot always be efficiently used unless the night be very fine and the air still. The well-known observer, Dawes, always used to judge the night by the aperture that could be employed. Thus he spoke of a one-inch night, two-inch night, up to an eight-inch night, this being the greatest aperture he possessed. As a matter of history, one may relate that a comparison of the drawings of Mars made by Sir Norman Lockyer with his six-inch refractor, and by Lord Rosse with his big reflector, showed that although both series were made at the same time, they displayed striking dissimilarities. Dawes, who had also made some valuable drawings at the same opposition, in discussing this question of dissimilarity, concluded that Lockyer's drawings were the more correct, since they were found to be exactly like those he (Dawes) had made, especially with regard to a certain marking which he had called the "double tooth."

Dawes, however, was no lover of large apertures, and on the occasion just referred to he was heard to repeat one of his favourite phrases, "What have the giants done?"

Apart, then, from the quality of the instrument employed, definition depends on the state of the atmosphere through which the light rays pass. On clear nights the question of the movements of the air is of the highest importance, and it is only on this movement that the aperture for any particular night can be gauged. In consequence of these air undulations, which vary in different currents from half an inch to several feet in length, the definition varies enormously.

In the case of a small aperture, and supposing the wave-length to be more than double the diameter of the object-glass, the image of the object under observation would only be bodily moved without confusion; for a large glass the image would be very considerably blurred.

Dr. T. J. J. See has recently (*Astr. Nach.* No. 3455) been making investigations on the sizes and movements of these aerial movements, and his paper on this subject indicates the importance of increasing our knowledge by more systematic study.

Thus it will be seen that in discussing the question of how large telescopes may be made to do useful work, a most important item to take into consideration is the locality in which they will be used. If such a spot be happily found, situated on a high plateau where the movement of the air is practically nil, then theoretically there seems no reason why apertures should be limited in size; but as such a condition as this is rarely if ever to be obtained, a limit is necessarily imposed on the diameters of object-glasses. W. J. S. LOCKYER.

## *THE WOBURN ABBEY DEER.*

FROM the difficulty of obtaining an adequate series of specimens, either living or dead, the deer are one of the groups of large mammals with regard to which our present state of knowledge is decidedly not up to date, comparatively little advance having been made since the appearance of the late Sir Victor Brooke's well-known synopsis in the *Proceedings* of the Zoological Society for 1878. Fortunately the noble owner of Woburn Abbey, who takes a great interest in animals of all kinds, is endeavouring to get together as complete a collection as possible of these beautiful and interesting ruminants, or rather of such kinds as experience shows to be best suited to withstand the vicissitudes of the English climate. With characteristic liberality the whole of the magnificent collection now assembled is accessible to zoologists interested in this group of animals, and by its means considerable additions have already been made to our knowledge thereof. From the extent of ground much larger numbers of specimens of the same species can be collected than is possible in the limited space available in the Zoological Society's Gardens in Regent's Park; and the conditions existing in a large country park are, of course, far more favourable to the well-being and display of the animals than is possible in London.

In the Regent's Park the larger kinds of deer, such as the American wapiti, are generally, from necessity, represented by only two or three individuals at a time, but at Woburn these and other species are assembled in herds of considerable size. And as deer are remarkable for their seasonal variations in coat and colour, it is in such manner only that a full grasp can be obtained of these periodical changes. A further advantage is the opportunity of seeing closely allied species or varieties either in the same paddock or in near juxtaposition; while the facilities for studying the habits of the animals are infinitely in advance of what is possible elsewhere.

For a long period of years the domain at Woburn has been a deer-park where large herds of red and fallow deer wander at their own sweet will; and the undulating wooded ground alternating with level expanses of excellent pasture, and the numerous lakes and ponds dotted over the latter area afford an ideal situation for all animals of this class. Such foreign species as adapt themselves easily to these conditions, and do not make themselves objectionable by developing habits of ferocity, are allowed to run at large in the open park. Among these are Père David's deer, of Northern China, the elk, the Virginian deer, and the Japanese and Manchurian sikas; while muntjacs and roe run wild among the coverts. Such an amount of liberty cannot, however, be permitted to many of the species on account of their dangerous propensities; while it is found convenient or necessary to afford more protection from the wind and weather to yet other kinds. But even in the case of species deprived of their full liberty, the amount of space accorded them is ample, and quite different from what is practicable in domains of smaller magnitude. The American wapiti, for instance, live in a "paddock" of about 150 acres, surrounded by an eight-feet iron fence; and in the same enclosure, as shown in our first illustration, run the various races of sambar, as well as some of the sikas, and various other small species. A small herd of American bison are also among the denizens of this enclosure. Hard by, in a paddock of but little inferior dimensions, is a magnificent herd of the Altai wapiti, a species first made known in this country by antlers obtained by the second Yarkand expedition in Kashgar, and described by Mr. Blanford. The herd includes the first living examples of this splendid species ever brought to this country, although visitors to the Zoological Gardens have now an opportunity of seeing an immature specimen. And it is not a little remarkable that a stag so well known in the Altai, where it is kept in a semi-domestic condition by the farmers, should so long have remained a stranger to the menageries of Europe.

Perhaps, however, the most generally attractive of all the enclosures is the one which may be called the Chital paddock, on account of its containing a large herd of the beautiful chital or Indian spotted deer. A most successful photograph of a group of deer feeding in this paddock, for which we are also indebted to Her Grace the Duchess of Bedford, forms the subject of the second illustration. In addition to numerous chital, easily recognised by their dappled coats, this photograph shows several examples of the true maral, or Caspian red deer, from the Caucasus, which are the largest animals in the photo. This deer, it may be observed, although often regarded as a distinct species, appears to be nothing more than a race, or sub-species, of the red deer of Western Europe. Of the other smaller animals in the group, a Virginian deer occupies the foreground on the left, while several mouflon, and at least one Indian antelope, or black-buck, are in the centre.

From the torrid nature of their environment, it might have been supposed that the Indian chital and black-buck would have been among the species least suitable to withstand our climate. Nevertheless, this is not the case, and whereas these animals thrive and multiply at Woburn to an extraordinary degree, some northern species, like the elk and reindeer, which might have been expected to flourish best, die off in an unaccountable manner. Out of several head of American elk only a solitary survivor now remains, while all the adult reindeer are dead. Some young American calves of the latter species have, however, been recently received, and it may be hoped their fate will be happier. Possibly if Norwegian reindeer and elk were tried, they might do better than their American representatives. But it must be remembered that both these animals have disappeared at a comparatively recent date from Britain; and there may be something in our climate at the present time absolutely unfavourable to their existence.

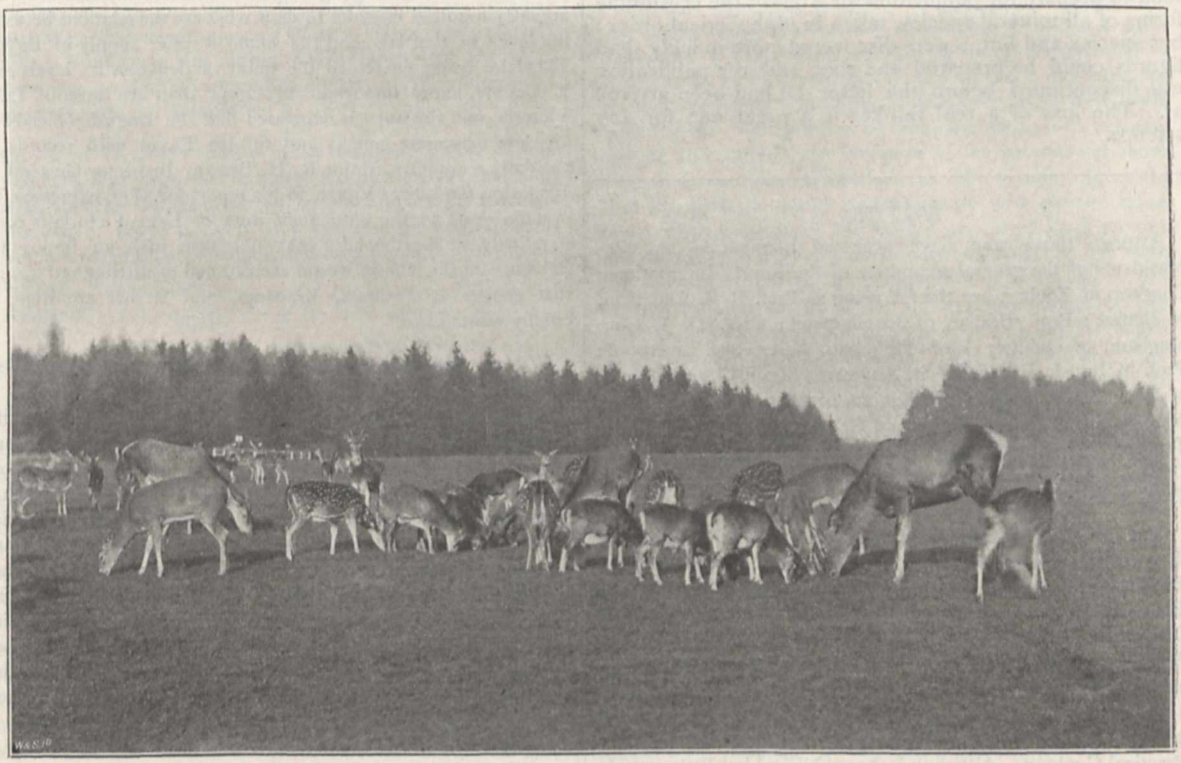
The various Oriental races of sambar and rusa flourish at Woburn equally well with the chital, and the large series of these animals now collected there affords material for a fairly full study of an exceedingly difficult group. Hog-deer and muntjacs are also among those which are hardy and capable of acclimatisation. Other Oriental species represented in the collection are the swamp-deer of India, and the thameng of Burma and Siam; but these are kept in smaller and well-protected enclosures, with ample shelter. From the colder nature of their habitat, the various species and races of the sikas of Japan and Northern China might naturally be expected to do well, and as a matter of fact this has been found to be the case. In addition to the common Japanese and Manchurian sikas, the collection includes the large and handsome Pekin sika, previously known only by the type specimens sent home by the late Consul Swinhoe after the sack of the Imperial Summer Palace. Père David's deer has been already mentioned as among

Wapiti. Wapiti. Sika. Bison. Wapiti. Wapiti. Sambar.

FIG. 1.—The American Wapiti Paddock at Woburn Abbey, showing Wapiti, Sambar, Sika, and Bison. (From a photograph by the Duchess of Bedford.)

those running at large in the park, and there is good prospect of the herd of this aberrant and interesting species increasing in number. A solitary male of the previously imperfectly known Bedford's deer (*Cervus xanthopygus*) has unfortunately succumbed to a lingering decline, although happily not till it exhibited the remarkable variation between the summer and winter pélage. Roe deer, of course, flourish; and recently there was the opportunity of seeing the European, Siberian, and Manchurian species, or races, living side by side. The rare Chinese water-deer (*Hydropotes*) is represented by a single doe, which exhibits to perfection the skulking habits peculiar to the species; but a specimen of Michie's tufted deer, which formerly was one of the attractions of the collection, now adorns the museum at the Abbey. Musk-deer do not belie their hardy nature, and it is one of the most interesting sights in the park to marsh deer and pampas deer. Young examples of each of these two latter are, however, at the present time in the collection, and as they are very carefully tended, and the experience derived from their predecessors is available, it may be hoped they will survive. A tiny little deer, apparently referable to *Mazama gymnotis*, is also among the newest arrivals, and its career will naturally be watched with deep anxiety. Brockets have been tried with hopeless ill-success, and the attempt to acclimatise them has reluctantly been abandoned.

During the very short period the collection has been in existence it has included, counting red and fallow deer, close on forty distinct species and races—no mean record when it is remembered that the total number of valid forms which have been exhibited in the London Zoological Gardens since its foundation does not exceed forty-eight. As every effort is being made to increase



Virginian. Chital. Mouflon. Chital. Mouflon. Caspian Red Deer.
Black-Buck.

FIG. 2.—The Chital Paddock at Woburn Abbey, with Chital, Virginian Deer, Caspian Red Deer, Mouflon, and Black-Buck. (From a photograph by the Duchess of Bedford.)

watch these little deer bounding across their enclosure in the manner so well-known to all Himalayan sportsmen.

In marked contrast to the adaptability of the Oriental deer to their new surroundings is the ill-luck attending the introduction of most of the American deer, exclusive of the wapiti. The only exception to this is the Virginian deer, which flourishes and breeds, some mingling with the chital herd, others roaming at will in the open park, and a few taking up their abode in the immediate vicinity of the Abbey itself. These latter exhibit tameness and fearlessness to an extraordinary degree—only, indeed, exceeded by the members of a little herd of roe from the Caucasus, one of which permits itself to be fondled like a pet lamb. Black-tailed and, we believe, mule-deer have been tried without success; while the same ill-fate has attended several examples of the South American

the Woburn collection, it bids fair to beat the record in the number of species, as it already does in individuals.

R. L.

## THE LATE PROFESSOR A. SCHRAUF.

THE comparatively small number of mineralogical workers and teachers has been once more diminished, and to the recent deaths of Mallard, Daubrée, DesCloizeaux, Sohncke, Retgers, Kenngott, Haughton and Heddle, must now be added that of Albrecht Schrauf, Professor of Physical Mineralogy in the University of Vienna, who has passed away, after long illness, near the end of the sixtieth year of his age. A. Schrauf was born on December 14, 1837; he became assistant in the Mineral Department of the Imperial Museum of Vienna in 1861, and Keeper in 1867; after

1862 he added to his Museum duties the work of a "Docent" in the University; but eventually (1877) retired altogether from the Imperial Museum to take upon himself the duties of the University Professorship, involving the care of the University Mineral Collection: in this office he remained till the end of his life.

Much of Schrauf's published work consists in the technical examination and description of mineral species, but he also gave much thought to the general and recondite problems connected with atoms and molecules and their relation to the physical characters of crystals: his earlier speculations are incorporated in his "Treatise on Physical Mineralogy" published in 1866-68, but the later are only to be found in isolated memoirs. He was also the author of a useful handbook on "Precious Stones" (1869). Interested deeply in the philosophy of his subject, he sought the necessary mental and physical relaxation in the mechanics of crystal drawing, and undertook to prepare for publication an Atlas of the crystalline forms of all mineral species, taken in alphabetical order: but species and forms were discovered more quickly than figures could be prepared and sold, and the publication was discontinued before the letter D had been arrived at. The loss of a real thinker is a great one for any science.

## *NOTES.*

AMONG those who have accepted nomination as vice-presidents of the general committee of the Fourth International Congress of Zoology are the following:—Prof. R. J. Anderson, of Belfast; Prof. Bridge, of Birmingham; Prof. D. J. Cunningham, of Dublin; Prof. Herdman, F.R.S., of Liverpool; Prof. M'Intosh, F.R.S., of St. Andrews; Mr. J. Cosmo Melvill, of Manchester; Prof. Lloyd Morgan, of Bristol; Prof. Alleyne Nicholson, F.R.S., of Aberdeen; Dr. Scharff, of Dublin; Dr. Traquair, F.R.S., of Edinburgh; Canon Tristram, F.R.S., of Durham; Lieutenant-Colonel R. G. Wardlaw Ramsay; and Prof. Percival Wright, of Dublin.

MR. GEORGE SHARMAN retires at the end of this year from the post of Palæontologist to the Geological Survey of Great Britain. Entering the service just before the death of De la Beche in 1855, he served for a while under the first Director-General, and subsequently under Murchison, Ramsay, and Sir Archibald Geikie, with Mr. J. W. Salter and Mr. R. Etheridge as his senior colleagues. On the retirement of Mr. Etheridge in 1881, he was promoted, together with Mr. E. T. Newton, to take charge of the palæontological collections in the Museum of Practical Geology. Although he has published but little outside the "Memoirs of the Geological Survey," Mr. Sharman has sedulously devoted himself to the study of British fossils, and more especially the Invertebrata, his acquaintance with which is unequalled. The important aid which he has continuously given for over forty years to the field-geologists of the Survey is shown to some extent in the lists of fossils published in the official "Memoirs"; but no inconsiderable portion of his time has been given to those inquirers who so frequently come to a public museum with bags and pockets full of fossils to be identified by the officers. His skill and patience, and his readiness to give information have combined to characterise his long career as one of marked and unselfish devotion to the public service.

THE death is announced of Prof. Wilhelm Joest, known by his travels in North Africa, America and Asia.

MR. HENRY CECIL, writing from Bournemouth, under date December 24, says:—"I was fortunate enough to see, at 1.13 this morning, in the middle of the latter half of its passage, the most remarkable meteor I ever saw. At that hour the sky was perfectly clear; and looking at the brilliant stars through the western of two windows looking south, I became suddenly aware of an intense white illumination overhead, which, from the steepness of the arc, could not, I think, have had its origin far to the westward of the zenith."

IN the course of an article upon Sir W. E. Garstin's report on the work of the Irrigation Department of Egypt in 1896, the *Times* mentions as a new indication of scientific progress in Africa, that, since January 1, 1896, the water levels of the Victoria Nyanza have been daily recorded by means of gauges erected at three places, viz. Port Alice, Port Victoria, and Lubwas Usoga. The readings, as also a monthly statement showing the rise and fall of the lake, are received at Cairo; but the records of a series of years are necessary before any attempt can be made certainly to prognosticate the extent of influence that a rise or fall of the lake waters may produce on the Nile. The report states that gauges upon the Albert Nyanza are very urgently required in order to show what are the relations between the levels of that lake and the summer water supply in Egypt. This lake being nearer to the point of delivery, its levels are, if possible, more important to Egypt than are those of Lake Victoria, and the hope is expressed that the English officials at Uganda may erect gauges and furnish Egypt with records of the daily readings. Major R. H. Brown, Inspector-General of Irrigation for Lower Egypt, in his report for 1896 expresses the opinion that, as the catchment area of Lake Victoria is comparatively small, the lake may not have such an important influence on the Nile as we are accustomed to attribute to it, and that gauges at Fashoda, Khartum, and Berber are what is chiefly wanted.

WE are glad to see that a Lincolnshire Science Society has been established. For many years there has been, in Lincolnshire, an absence of combination among scientific workers. Of individual investigators there is no lack, and much valuable work has been carried on by them; but from a want of knowledge of what has been, and what is being done by others in the special subjects in which each is interested, there has been a waste of time and energy. A central, organising, directive force has been wanting; and it is to supply this want, and to give to individuals and to the local county societies an opportunity for combining forces for the purpose of centralising and directing their efforts so that their various plans of action may be harmonised, that the Lincolnshire Science Society has been called into existence. The Society consists of a number of sections, the members of each of which devote themselves to the working out of one or more lines of research in the sciences that the sections represent. The presidents of the sections form the Council of the Society, and it is a part of their duty to suggest to the members and to the affiliated societies such lines of research and such methods as will be likely to yield the best results. The Society is at present actively helping on a scheme having for its object the foundation and the endowment of a county museum. The object is a worthy one, and we trust that both it and the Society will meet with the fullest encouragement and success. Particulars referring to the Society may be obtained from the president, Dr. G. M. Lowe, the hon. sec., Mr. G. Grierson, or the vice-president, Mr. J. H. Cooke, Thorndale, Lincoln.

A FRESH contribution to our knowledge of the physiological effects of high altitudes is given by Prof. Piero Giacosa (*Rendiconti del R. Istituto Lombardo*, xvii.), who has studied more especially their influence on the exchange of material, and particularly on the elimination of nitrogen. Prof. Giacosa considers that as the altitude of 6000 metres is approached, there is an increasing risk of reaching the limit beyond which the physiological functions cannot be completed; but below 6000 metres the diminished pressure is never a direct and sufficient cause of the disorders that are observed, and its only effect is to aggravate those due to fatigue, to impaired digestion, and to other causes.

WRITING in the *Memorie della Società degli spettroscopisti Italiani*, xxvi., Dr. G. B. Rizzo publishes the details of a number of observations for determining the value of the solar constant. This value could not be determined with sufficient accuracy from experiments made at one station alone, as it was found that the results varied largely according to the formula employed; observations should therefore be taken at several stations differing considerably in altitude, but at no great horizontal distance apart. Four stations were therefore selected on Monte Rocciamelone, in the Val di Susa, at altitudes of 501, 1722, 2834 and 3537 metres, and by determining the intensity of solar radiation, referred to the zenith, at these stations, the relations between this intensity and the corresponding atmospheric pressure were expressed by means of two independent empiric formulæ. From these the author finally infers that the solar constant has a value of approximately 2·5 small calories per square centimetre per minute.

MR. R. F. ARNOTT writes to us from Sělángor, Straits Settlements, with reference to a note on the alleged conversion of Mexican silver dollars into gold, by Dr. Stephen H. Emmens (September 9, 1897, p. 451). He has assayed four Mexican dollars in circulation at Sělángor, and found gold in appreciable quantity, as follows:—

| Number of assay. | Marks. | Gold. |
|---|---|---|
| 1. ... | 8 R.G.A 1874 I.G. ... | 0·06 per cent. |
| 2. ... | 8 R.O.A 1892 E.N. ... | 0·09 ,, |
| 3. ... | 8 R.G.A 1893 J.S. ... | 0·08 ,, |
| 4. ... | 8 R.G.A 1895 M.M. ... | 0·01 ,, |

The dollars were taken at random from rather more than a hundred different issues, and no unusual treatment was employed during assay. The results are worth putting on record, as they suggest a possible origin of the gold in the "argentaurum" manufactured by Dr. Emmens. It is, however, well known that gold exists in Mexican dollars. Our attention has been called to the fact that in 1891 an examination of 11,846 such coins was made at the Royal Mint (see Report of the Deputy-Master of the Mint for 1891, pp. 110-113). The dollars from all the Mexican mints were found to contain gold, the average amount being 0·309 per 1000. Those from Guadalajara (Nos. 1, 3 and 4 of Mr. Arnott) numbered 463, and contained an average of 0·964 of gold per 1000. In connection with the presence of gold in silver, Mr. Arnott points out that much of the silver received at the Indian mints some years ago was rich in gold; sycee containing an average of about 0·9 per cent., and silver coins issued contained as much as 0·09 per cent. of gold.

THE attention of the commercial interests of Germany has recently been directed to the great advantage that would be derived to the trade of that country by the completion of the canal system joining the Black Sea with the North Sea, and also with the Baltic. At present all merchandise conveyed to and from the East has to go round by sea to Hamburg or Stettin, the distance by sea being more than 3000 miles as compared with about 1000 miles through Austria and Germany by a system of inland waterways. Two Congresses have recently been held —one at Passau, in Bavaria, and the other at Vienna—for the study and discussion of schemes for developing this through communication, and the Ministry of Commerce at Vienna has had inquiries made as to the feasibility of the plans proposed. These are to open out and improve the Ludwig Canal, which connects the Danube with the Main, and so with the Rhine, so as to make it available for barges carrying 500 tons, and thus completing a direct water-way between the Black and North Seas. The length of this canal is 106 miles, and it now has a depth of water of only five feet and a navigation fitted for 127-ton barges. The second part of the proposed scheme is to connect the Danube with the Elbe by a new canal from the former, near Vienna, turning in a north-west direction to join the Upper Moldau, and by the canalisation of this river to Prague, and of the Elbe to Aussen. The third scheme is to connect the Austrian and German water-ways by connecting the March, an effluent of the Danube, with the Oder, and making the system capable of taking 600-ton barges, and thus connecting the Black Sea with the Baltic. The Russian scheme, having a similar object, and described in NATURE of February 25, is to be commenced forthwith.

THE latest issue of the *Memoirs* of the Caucasian branch of the Russian Geographical Society (vol. xvii. part 1), contains the first part of a very valuable work, by A. V. Voznesensky, on the precipitation in Caucasia. The author gives first a series of tables, for 113 Caucasian stations, showing the amounts of rain and snow, and the numbers of days with rain or snow, for every month of every year during which observations were made at each station. The position of each observatory—its latitude, longitude and altitude, the elevation of the pluviometer above the ground, and general remarks are also given; and at the end of the work the results are summed up in a general table. Sixteen maps accompany the work: one of them is an orographical map of Caucasia; then come two series, of five maps each, showing by curves the geographical distribution of precipitation over the territory, *i.e.* the average amount of precipitation, and the probability of snow or rain for the whole year and for each season separately. The distribution of precipitation during the different months of the year is next represented by diagrams for thirty stations; and seven different types having thus been established, the geographical distribution of the regions belonging to each of these types is given on a map. Another map shows the more or less uniformity which exists in the distribution of precipitation during the year in various parts of Caucasia; and two more maps represent by curves the regions of summer and winter droughts, as well as the intermediate regions. The text in which the general conclusions had to be discussed has been left for a second part of the same work, the author having had to leave the Caucasus to take up the management of a meteorological station at Irkutsk.

IT is thirty-five years since the late Mr. S. P. Woodward described the remarkable fossil *Barrettia* from the Cretaceous limestone of Jamaica. Though in general appearance it resembled an operculate coral, Mr. Woodward came to the conclusion that it was really an aberrant Lamellibranch of the Hippurite group. Since that time nothing has been added to our knowledge of the form; but in a recent *Bulletin* of the American Museum of Natural History, Mr. R. P. Whitfield gives the results of his study of a large series of specimens obtained from the original locality, which show certain additional details of structure. He cannot agree that *Barrettia* was a Lamellibranch, but strongly inclines to place it among the corals: it certainly is a very isolated form, as the only corals with which he is able to suggest comparisons in structure are of Palæozoic age.

"DO the crystalline gneisses represent portions of the original earth's crust?" is the question asked, and answered in the affirmative, by Mr. J. Lomas, in his recent presidential address to the Liverpool Geological Society (published in the December *Geological Magazine*). Excluding gneisses of later igneous or metamorphic origin, there remain the great series of fundamental gneisses, world-wide in distribution and uniform in general character, which must have had some world-wide cause of origin. As a possible cause of their foliation, Mr. Lomas suggests tidal action in the incompletely-consolidated crust. Prof. G. H. Darwin has shown that huge tidal wrinkles must have been raised by the moon when near the earth, forming ridges and troughs which ran north and south near the Equator, and curved to the eastward as they approached the Poles. The strike of the gneisses of Britain and Scandinavia corresponds to the direction of these tidal wrinkles in those latitudes, and there is evidence that the Palæozoic strata were deposited in troughs parallel to the gneissic ridges. In Anglesey, according to Mr. Lomas, we have a portion of one such ridge that may never have been submerged under the sea.

THE Cambridge University Press has just published a volume of "Solutions of the Exercises in Taylor's Euclid" (Pitt Press Mathematical Series), Books VI.–XI.

MR. H. TRIMBLE reprints, from the *American Journal of Pharmacy*, a series of papers by himself and the late Prof. E. S. Bastin, on "Some North American Coniferæ." Some of the more important American species from an economical point of view are described in detail, special attention being given to the microscopical structure of the leaf and stem and to the chemical composition of the wood. Excellent photographs are given to show the habit of each species, and woodcuts of microscopic sections.

A SECOND edition of Mr. Arthur Mee's "Observational Astronomy," greatly enlarged and improved, has just been published by the office of the *Western Mail*, Cardiff. The new edition is, in point of illustration, vastly superior to the original work, some of the half-tone blocks being very fine reproductions; the text also has been through the refining fire. The volume should be in the possession of every amateur astronomer, however limited his instrumental equipment may be; for it will bring him right into the current of astronomical thought, and inspire him to make the best use of his opportunities.

VOL. VIII., part 1, of the *Proceedings* of the Liverpool Geological Society contains a valuable series of papers. These include the presidential address on "Glacial Geology," and a paper on "Ayrshire Geology," by Mr. Mellard Reade; detailed and illustrated accounts of the "Carboniferous Limestone of the Clwyd Valley," by Mr. G. H. Morton; of the "Igneous Rocks of Aran Mowddwy," by Mr. T. H. Cope; and of the "Varanger Fjord," by Messrs. Dickson and Holland. Mr. Lomas investigates the earthquake of December 17, 1896, and traces the isoseismal lines; and Dr. Callaway criticises the chemical evidence for the existence of organisms in Archæan times, finding it quite fallacious.

THE Thornton-Pickard Manufacturing Company, Ltd., have sent us a copy of their new illustrated catalogue for 1898. Several very fine half-tone reproductions of photographs illustrate the catalogue, and testify to the excellence of results obtained with cameras and instantaneous shutters manufactured by the firm. Among the apparatus which call for special mention are a new 5 × 4 size of the Amber camera, a new patent film carrier, and a new aluminium shutter. The firm offers 200*l*. in prizes for the best results obtained with their cameras and shutters. Full particulars of this competition, as well as many serviceable hints to photographers, will be found in the catalogue, a copy of which will be forwarded on application.

WE have received the yearly report of the Russian Geographical Society for the year 1896, and it is full of interest. It contains, as usual, the obituaries of the members whom the Society lost during the year, condensed reports of the expeditions of the Society, a review of its publications, and excellent accounts of the work done by those geographers to whom medals were awarded by the Society in 1896. Very valuable feature of this year's reports are the yearly reports of the Siberian branch of the Society (Irkutsk) and of the Amur branch (Khabarovsk) for the years 1894 and 1895, as also of the Society for the Study of the Amur Region for the year 1895. Unfortunately, one does not find in the report any information concerning the extremely interesting but almost quite unknown activity of the West Siberian branch of the Russian Geographical Society.

A SECOND edition of Prof. J. J. Thomson's "Elements of the Mathematical Theory of Electricity and Magnetism" has just been published by the Cambridge University Press. The first edition, published in 1895, was reviewed in NATURE (vol. liv. p. 97), and as few alterations have been made, we need do no more than announce the appearance of the new edition, and express pleasure that the work is finding its way into the hands of an increasing number of students.—Prof. J. A. Ewing's work on "The Steam Engine and other Heat Engines" (Cambridge University Press), reviewed in NATURE three years ago (vol. li. p. 219), has also reached a second edition. A considerable amount of new matter has been added to the volume, and the section relating to gas engines has been much extended. To the thoughtful student of engineering science the book is invaluable. —Part 2 of "An Illustrated Manual of British Birds," by Mr. Howard Saunders, has been published by Messrs. Gurney and Jackson. The work will be completed in twenty parts, and will contain illustrations of nearly every species.

THE annual report on the work of the Institute of Jamaica has been received. The Science Section of the Institute appears to have been particularly active in the period covered by the report. A number of changes have been made in the systematic arrangement of the objects in the museum. In the zoological collection a 4 to 6 per cent. solution of formalin has been mostly employed as a preservative fluid and found to work very satisfactorily, though the colours of the objects were not retained for long in specimens exposed to strong light. For delicate objects, such as jellyfish and sea-anemones, it is found to be extremely serviceable, preserving perfectly the natural form and histology. Research work, mainly upon the Actinaria of the island, has been continued in the Biological Laboratory of the Institute. A paper on the Jamaica Zoanthidæ, embracing a description of ten species, has been prepared by the curator for publication; also one on the Actinian family Aliciidæ, describing, amongst others, a new Jamaica species of Bunodeopsis. During the summer months three students from the Johns Hopkins University, under the direction of Prof. Brooks, established a temporary marine laboratory at Port Henderson. Contributions to Jamaican zoology have been made by them, and many specimens were presented to the museum. Investigations of Indian remains have been continued from last year, and more valuable material collected from the caves and refuse-heaps. The objects, however, do not differ greatly in type from those referred to in the last report. An account of the results, illustrated with numerous figures, plates, and a map, will shortly be published in the *Journal* of the Institute. The report thus shows that the Institute is actively assisting in the advancement of knowledge, as well as working in various ways to create and stimulate interest in scientific objects and study.

IN the current number of the *Berichte*, P. Walden describes the very remarkable effect produced by the addition of a uranyl salt to a solution of an optically active substance. When a substance such as *l*-malic acid is dissolved in water along with one molecule of uranyl nitrate and about four molecules of caustic potash, the rotation produced by the solution is more than five hundred times as great as that of the acid alone, whilst it remains of the same sign. Similar, but less intense effects are observed with other optically active hydroxy-acids and their ethereal salts, but no increase is produced with optically active substances, such as chlorosuccinic acid, which do not contain a hydroxyl group, and indeed a slight diminution is caused in some of these cases. Optically inactive acids, such as mesotartaric acid, inactive malic acid, &c., are quite unaffected by the addition of these substances. Apart from its high theoretical interest, the phenomenon provides a ready method of distinguishing active substances of low rotatory power from their inactive isomerides.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Black-backed Jackal (*Canis mesomelas*, ♀) from South Africa, presented by Major Haynes Sadler; a Red-bellied Wallaby (*Macropus billardieri*) from Tasmania, presented by Mrs. Beaumont; a Guillemot (*Lomvia troile*), British, presented by Mr. John Pettitt; a Yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, a Marsh Harrier (*Circus æruginosus*), European, deposited; six Summer Ducks (*Æx sponsa*, 5 ♂, 1 ♀), purchased.

## *OUR ASTRONOMICAL COLUMN.*

ASTRONOMICAL OCCURRENCES IN JANUARY:—

| January | h. m. | | h. m. | |
|---|---|---|---|---|
| 2. | | | | Meteoric shower from Quadrans (230° + 52°). |
| 3. | 6 59 | to | 8 16. | Occultation of 16 Tauri (mag. 6·5). |
| 3. | 7 13 | ,, | 8 27. | ,, 17 ,, 3·8). |
| 3. | 8 2 | ,, | 9 11. | ,, 23 ,, 4·2). |
| 3. | 8 46 | ,, | 10 8. | ,, η ,, 3·0). |
| 3. | 9 55 | ,, | 11 11. | ,, 28 ,, 6·2). |
| 3. | 10 1 | ,, | 10 59. | ,, 27 ,, 3·8). |
| 5. | | | | Uranus 52′ S. of β Scorpii. |
| 5. | 12 56 | to | 13 58. | Occultation of 125 ,, 4·9) |
| 7. | 10 57 | ,, | 12 32. | Partial eclipse of the moon. Magnitude 0·157 at 11h. 45m. |
| 9. | 8 11 | ,, | 9 8. | Occultation of o′ Cancri (mag. 5·2). |
| 10. | 15 53 | ,, | 17 4. | Occultation of B.A.C. 3398 (mag. 6·0). |
| 14. | 5 | | | Jupiter in conjunction with moon. ♃ 7° 5′ N. |
| 17. | 16 30 | to | 17 31. | Occultation of B.A.C. 5314 (mag. 5·4). |
| 17. | 18 51 | ,, | 20 1. | ,, ,, 5347 ,, 5·8). |
| 18. | 7 | | | Saturn in conjunction with moon. ♄ 5° 40′ N. |
| 18. | 12 53 | to | 15 25. | Transit of Jupiter's Satellite III. |
| 20. | 8 31. | | | Minimum of β Persei (Algol). |
| 21. | | | | Total eclipse of the sun invisible at Greenwich. Begins on the earth generally 16h. 46m., ends 21h. 53m. |
| 23. | 5 20. | | | Minimum of β Persei (Algol). |
| 25. | 11 56 | to | 14 52. | Transit of shadow Jupiter's Sat. III. |
| 25. | 16 37 | ,, | 19 6. | ,, Jupiter's Sat. III. |
| 29. | 4. | | | Mercury at greatest elongation (25° 4′ W.) |

"NAUTICAL ALMANAC" CORRIGENDA.—In a letter to the *Journal* of the British Astronomical Association, Dr. A. M. W. Downing forcibly impresses upon astronomers the necessity and importance of consulting the page of *errata* in each issue of the *Nautical Almanac*. In consequence of the *Nautical Almanac* going to press four years in advance, any corrections to data influencing the tables gives, of course, slightly modified results. We read, for instance, that "in the first edition of the *Nautical Almanac* for 1898 (issued in December 1894) the data are affected by an error which throws out the times of the lunar eclipses to a considerable extent; in the second edition (issued last April), and in a subsequent edition, now being struck off, this error has been corrected. The correct data are also given amongst the *errata* on page xiii of the *Nautical Almanac* 1899. It will therefore be advisable for those interested in these phenomena, should they happen to possess the first edition of the *Nautical Almanac* for 1898, to correct the data for lunar eclipses in that edition by the *errata* given in the *Nautical Almanac* for 1899."

Another correction in the same edition is the position of 16 Tauri in the Pleiades, which makes an occultation of this star on January 3 a near approach only.

OCCULTATION OF THE PLEIADES.—For the third time in less than half a year the Pleiades will suffer occultation by the moon on January 3. As in the case of the occultation which took place last October, all the brighter stars will be occulted with the exception of 16 Tauri (see note on "*Nautical Almanac* Corrigenda"), and this star, although approaching very near, is just missed. The most interesting occultation will be that of Alcyone (mag. 3·0), the brightest star in the Pleiades, and its disappearance at the dark limb should be seen with the smallest telescope. The times are as follow:—

Time of disappearance, January 3d. 8h. 46m. G.M.T.
,, reappearance ,, 10h. 8m. ,,

The Iris Gulf will be in the neighbourhood of the terminator where the star disappears.

The passage of the moon before the Pleiades, although a beautiful phenomenon at any time, in this case loses some of its charm through the brightness of the moon, her age being nearly 11 days, and consequently the aërial reflection will overpower the fainter stars of this group.

PARTIAL ECLIPSE OF THE MOON.—That the moon is getting into position for eclipsing the sun on January 22 is announced by the fact that she herself is under partial eclipse at the preceding lunation on January 7. The phenomenon commences a little before midnight, and ends an hour and a half after.

The eclipse is a very small one, its magnitude being only 0·157 (moon's diameter = 1).

The following are the corrected phases as given in the *Nautical Almanac* (1898) (see note on "*Nautical Almanac* Corrigenda.")

| | | d. | h. | m. | |
|---|---|---|---|---|---|
| First contact with the penumbra, | January | 7 | 10 | 1·2 | p.m. |
| ,, ,, ,, shadow | ,, | | 11 | 47·4 | ,, |
| Middle of eclipse | ,, | 8 | 0 | 34·9 | a.m. |
| Last contact with the shadow | ,, | | 1 | 22·4 | ,, |
| ,, ,, ,, penumbra | ,, | | 3 | 8·6 | ,, |

NEW INVESTIGATIONS OF β LYRÆ.—Prof. A. Belopolsky has recently completed a new series of photographs in connection with the spectrum variations of β Lyræ; and his paper on "New investigations of the spectrum of β Lyræ" appears in the *Astrophysical Journal*, November 1897. In all, twenty-six photographs have been taken corresponding to all the phases of brightness, and the results are especially interesting since an "iron comparison" has enabled him to determine the velocity of the system with respect to the sun, and also the radial velocities at different parts of the orbit.

The dark line at λ 4482 has been utilised in making all the measures, for this line changes but little in appearance, whilst the lines λ 4471, $H_\beta$ and $H_\gamma$ undergo great variations.

From measures made of the above line, with the iron comparison as datum lines, he finds that the proper motion of the system = −2·00 geographical miles, and the maximum radial velocity is about 25 geographical miles. Moreover, the curve of radial velocities shows that the changes of brightness may be sufficiently well explained by an *eclipse*; for the times of radial velocity = 0 are very close to the times of principal and secondary minima. His description of the cyclical changes which take place in the appearances of the lines at λλ 4471 and 4482, and the reappearance of certain additional lines at particular phases agrees remarkably well with the Kensington results, which, it may be remembered, showed that of the components producing the dark lines, one was like Bellatrix, and the other gave a spectrum similar to that of Rigel.

THE ATMOSPHERES OF PLANETS.—Dr. Johnstone Stoney's name has long been connected with an important theorem in molecular physics, which may be thus stated. The atmosphere round any planet will extend to a height determined by the force of gravity on that planet, and if the speed with which the molecules move in that atmosphere exceed a critical velocity, they will escape from the planet and move independently in space. In the *Transactions* of the Royal Dublin Society, November 1897, Dr. Stoney has given in some detail his full views on this subject, and substituted better numerical results for those originally given in scattered scientific papers, by basing them on the fact that helium, whose density is twice that of hydrogen, can, and does, escape from the earth. It is contended that helium is continually being supplied to the earth's atmosphere from hot springs, that it exhibits no tendency to combine with other elements, and since no trace of it can be found in the atmosphere, it escapes above, as rapidly as it enters below. Water vapour, on the other hand, remains on the earth, and consequently limits of speed can be assigned between which gases are either imprisoned or are free to escape. For the earth, under favourable circumstances, a velocity of 10·5 km. per sec. would be sufficient to carry a molecule beyond gravitational control, and this is 6·5 times the "velocity of mean square" in hydrogen gas at a temperature of − 66° C.; 9·27 times that of helium at the same temperature, and 19·66 times that of water vapour. Since the two former gases escape and the latter does not, it would seem that the velocity attained by molecules can exceed nine times the average velocity, but cannot reach that of twenty. Assuming that Venus retains a moisture-laden atmosphere, about which Dr. Stoney seems very positive, this latter number can be reduced to eighteen, and thus still closer express the actual velocity in terms of that of the "mean square."

Limiting the inquiry to a temperature of − 66° C., Dr. Stoney applies the theory to all members of the solar system with the following results. From the moon all gases having a vapour density less than 39 will escape with greater promptness than helium does from the earth. On Mercury, water cannot exist, while nitrogen and oxygen would gradually dribble away. The conditions on Venus resemble those on the earth, but the case of Mars is of exceptional interest. Dr. Stoney says that it is legitimate to infer that on this planet water cannot remain. The atmosphere he considers to consist mainly of nitrogen, argon, and carbon dioxide. He thinks there is no vegetation, as we understand the term, on the surface of the planet, and the snow, frost, and fog do not arise from the same cause as on the earth. Jupiter is able to imprison all gases known to chemists, but whether the more distant members of our system can retain hydrogen is doubtful. Helium and the denser gases probably float in their atmospheres, but the molecules of the lighter gases are describing orbits about the sun, the velocity they can acquire enabling them to escape from planetary control, but still insufficient to liberate them from the gravitational influence of the sun.

## *THE DENSITIES OF CERTAIN GASES.*[1]

THE observations here recorded were carried out by the method and with the apparatus described in a former paper,[2] to which reference may be made for details. It must suffice to say that the globe containing the gas to be weighed was filled at 0° C., and to a pressure determined by a manometric gauge. This pressure, nearly atmospheric, is slightly variable with temperature on account of the expansion of the mercury and iron involved. The actually observed weights are corrected so as to correspond with a temperature of 15° C. of the gauge, as well as for the errors in the platinum and brass weights employed. In the present, as well as in the former, experiments I have been ably assisted by Mr. George Gordon.

### *Carbonic Oxide.*

This gas was prepared by three methods. In the first method a flask, sealed to the rest of the apparatus, was charged with 80 grams recrystallised ferrocyanide of potassium and 360 c.c. strong sulphuric acid. The generation of gas could be started by the application of heat, and with care it could be checked and finally stopped by the removal of the flame with subsequent application, if necessary, of wet cotton wool to the exterior of the flask. In this way one charge could be utilised with great advantage for several fillings. On leaving the flask the gas was passed through a bubble containing potash solution (convenient as allowing the rate of production to be more easily estimated), and thence through tubes charged with fragments of potash and phosphoric anhydride, all connected by sealing. When possible, the weight of the globe *full* was compared with the mean of the preceding and following weights *empty*. Four experiments were made with results agreeing to within a few tenths of a milligram.

In the second set of experiments the flask was charged with 100 grams of oxalic acid and 500 c.c. strong sulphuric acid. To absorb the large quantity of $CO_2$ simultaneously evolved a plentiful supply of alkali was required. A wash-bottle and a long nearly horizontal tube contained strong alkaline solution, and these were followed by the tubes containing solid potash and phosphoric anhydride as before.

[1] "On the Densities of Carbonic Oxide, Carbonic Anhydride, and Nitrous Oxide." By Lord Rayleigh, F.R.S. (Read at the Royal Society, December 9, 1897.)

[2] "On the Densities of the Principal Gases," *Roy. Soc. Proc.*, vol. liii. p. 134, 1893.

For the experiments of the third set *oxalic* acid was replaced by *formic*, which is more convenient as not entailing the absorption of large volumes of $CO_2$. In this case the charge consisted of 50 grams formate of soda, 300 c.c. strong sulphuric acid, and 150 c.c. distilled water. The water is necessary in order to prevent action in the cold, and the amount requires to be somewhat carefully adjusted. As purifiers, the long horizontal bubbler was retained and the tubes charged with solid potash and phosphoric anhydride. In this set there were four concordant experiments. The immediate results stand thus:—

*Carbonic Oxide.*

| | |
|---|---|
| From ferrocyanide ... ... ... | 2·29843 |
| ,, oxalic acid ... ... ... ... | 2·29852 |
| ,, formate of soda ... ... ... | 2·29854 |
| Mean... ... ... ... | 2·29850 |

This corresponds to the number 2·62704 for oxygen (*loc. cit.*, p. 144), and is subject to a correction (additive) of 0·00056 for the diminution of the external volume of the globe when exhausted.

The ratio of the densities of carbonic oxide and oxygen is thus 2·29906 : 2·62760; so that if the density of oxygen be taken as 32, that of carbonic oxide will be 27·9989. If, as some preliminary experiments by Dr. Scott (*Camb. Phil. Proc.*, vol. ix. p. 144; 1896) indicate, equal volumes may be taken as accurately representative of CO and of $O_2$, the atomic weight of carbon will be 11·9989 on the scale of oxygen = 16.

The very close agreement between the weights of carbonic oxide prepared in three different ways is some guarantee against the presence of an impurity of widely differing density. On the other hand, some careful experiments led Mr. T. W. Richards (*Amer. Acad. Proc.*, vol. xviii. p. 279, 1891) to the conclusion that carbonic oxide is liable to contain considerable quantities of hydrogen or of hydrocarbons. From 5½ litres of carbonic oxide passed over hot cupric oxide he collected no less than 25 milligrams of water, and the evidence appeared to prove that the hydrogen was really derived from the carbonic oxide. Such a proportion of hydrogen would entail a deficiency in the weight of the globe of about 11 milligrams, and seems improbable in view of the good agreement of the numbers recorded. The presence of so much hydrogen in carbonic oxide is also difficult to reconcile with the well-known experiments of Prof. Dixon, who found that prolonged treatment with phosphoric anhydride was required in order to render the mixture of carbonic oxide and oxygen inexplosive. In the presence of relatively large quantities of free hydrogen (or hydrocarbons) why should traces of water vapour be so important?

In an experiment by Dr. Scott (*Chem. Soc. Trans.*, 1897, p. 564), 4 litres of carbon monoxide gave only 1·3 milligrams to the drying tube after oxidation.

I have myself made several trials of the same sort with gas prepared from formate of soda exactly as for weighing. The results were not so concordant as I had hoped,[1] but the amount of water collected was even less than that given by Dr. Scott. Indeed, I do not regard as proved the presence of hydrogen at all in the gas that I have employed.[2]

### *Carbonic Anhydride.*

This gas was prepared from hydrochloric acid and marble, and after passing a bubbler charged with a solution of carbonate of soda, was dried by phosphoric anhydride. Previous to use, the acid was caused to boil for some time by the passage of hydrochloric acid vapour from a flask containing another charge of the acid. In a second set of experiments the marble was replaced by a solution of carbonate of soda. There is no appreciable difference between the results obtained in the two ways; and the mean, corrected for the errors of weights and for the shrinkage of the globe when exhausted, is 3·6349, corresponding to 2·6276 for oxygen. The temperature at which the globe was charged was 0° C., and the actual pressure that of the manometric gauge at about 20°, reduction being made to 15° by the use of Boyle's law. From the former paper it appears that the actual height of the mercury column at 15° is 762·511 mm.

[1] One obstacle was the difficulty of re-oxidising the copper reduced by carbonic oxide. I have never encountered this difficulty after reduction by hydrogen.

[2] In Mr. Richards' work the gas in an imperfectly dried condition was treated with hot platinum black. Is it possible that the hydrogen was introduced at this stage?

*Nitrous Oxide.*

In preliminary experiments the gas was prepared in the laboratory, at as low a temperature as possible, from nitrate of ammonia, or was drawn from the iron bottles in which it is commercially supplied. The purification was by passage over potash and phosphoric anhydride. Unless special precautions are taken the gas so obtained is ten or more milligrams too light, presumably from admixture with nitrogen. In the case of the commercial supply, a better result is obtained by placing the bottles in an inverted position so as to draw from the *liquid* rather than from the *gaseous* portion.

Higher and more consistent results were arrived at from gas which had been specially treated. In consequence of the high relative solubility of nitrous oxide in water, the gas held in solution after prolonged agitation of the liquid with impure gas from any supply, will contain a much diminished proportion of nitrogen. To carry out this method on the scale required, a large (11-litre) flask was mounted on an apparatus in connection with the lathe so that it could be vigorously shaken. After the dissolved air had been sufficiently expelled by preliminary passage of $N_2O$, the water was cooled to near 0° C. and violently shaken for a considerable time while the gas was passing in large excess. The nitrous oxide thus purified was expelled from solution by heat, and was used to fill the globe in the usual manner.

For comparison with the results so obtained, gas purified in another manner was also examined. A small iron bottle, fully charged with the commercial material, was cooled in salt and ice and allowed somewhat suddenly to blow off half its contents. The residue drawn from the bottle in one or other position was employed for the weighings.

Nitrous Oxide (1896).

| | | | |
|---|---|---|---|
| Aug. 15 | Expelled from water | ... | 3·6359 |
| ,, 17 | ... | ... | 3·6354 |
| ,, 19 | From residue after blow off, | valve downwards | 3·6364 |
| ,, 21 | ,, ,, | valve upwards ... | 3·6358 |
| ,, 22 | ,, ,, | valve downwards | 3·6360 |
| | Mean | ... | 3·6359 |

The mean value may be taken to represent the corrected weight of the gas which fills the globe at 0° C. and at the pressure of the gauge (at 15°), corresponding to 2·6276 for oxygen.

One of the objects which I had in view in determining the density of nitrous oxide was to obtain, if it were possible, evidence as to the atomic weight of nitrogen. It may be remembered that observations upon the density of pure nitrogen, as distinguished from the atmospheric mixture containing argon which, until recently, had been confounded with pure nitrogen, led [1] to the conclusion that the densities of oxygen and nitrogen were as 16 : 14·003, thus suggesting that the atomic weight of nitrogen might really be 14 in place of 14·05, as generally received. The chemical evidence upon which the latter number rests is very indirect, and it appeared that a direct comparison of the weight of nitrous oxide and of its contained nitrogen might be of value. A suitable vessel would be filled, under known conditions, with the nitrous oxide, which would then be submitted to the action of a spiral of copper or iron wire rendered incandescent by an electric current. When all the oxygen was removed, the residual nitrogen would be measured, from which the ratio of equivalents could readily be deduced. The fact that the residual nitrogen would possess nearly the same volume as the nitrous oxide from which it was derived would present certain experimental advantages. If, indeed, the atomic weights were really as 14 : 16, the ratio ($x$) of volumes, after and before operations, would be given by

$$\frac{2\cdot2996 \times x}{3\cdot6359 - 2\cdot2996 \times x} = \frac{14}{8},$$

whence
$$x = \frac{7 \times 3\cdot6359}{11 \times 2\cdot2996} = 1\cdot0061,$$

3·6359 and 2·2996 being the relative weights of nitrous oxide and of nitrogen which (at 0° C. and at the pressure of the gauge) occupy the same volume. The integral numbers for the atomic weights would thus correspond to an expansion, after chemical reduction, of about one-half per cent.

But in practical operation the method lost most of its apparent simplicity. It was found that copper became unmanageable at a temperature sufficiently high for the purpose, and recourse was had to iron. Coils of iron suitably prepared and supported could be adequately heated by the current from a dynamo without twisting hopelessly out of shape; but the use of iron leads to fresh difficulties. The emission of carbonic oxide from the iron heated in vacuum continues for a very long time, and the attempt to get rid of this gas by preliminary treatment had to be abandoned. By final addition of a small quantity of oxygen (obtained by heating some permanganate of potash sealed up in one of the leading tubes) the CO could be oxidised to $CO_2$, and thus, along with any $H_2O$, be absorbed by a lump of potash placed beforehand in the working vessel. To get rid of superfluous oxygen, a coil of incandescent copper had then to be invoked, and thus the apparatus became rather complicated.

It is believed that the difficulties thus far mentioned were overcome, but nevertheless a satisfactory concordance in the final numbers was not attained. In the present position of the question no results are of value which do not discriminate with certainty between 14·05 and 14·00. The obstacle appeared to lie in a tendency of the nitrogen to pass to higher degrees of oxidation. On more than one occasion, mercury (which formed the movable boundary of an overflow chamber) was observed to be attacked. Under these circumstances I do not think it worth while to enter into further detail regarding the experiments in question.

The following summary gives the densities of the various gases relatively to air, all obtained by the same apparatus.[1] The last figure is of little significance.

| | |
|---|---|
| Air free from $H_2O$ and $CO_2$ ... ... | 1·00000 |
| Oxygen ... ... ... ... ... | 1·10535 |
| Nitrogen and argon (atmospheric) ... | 0·97209 |
| Nitrogen ... ... ... ... ... | 0·96737 |
| Argon ... ... ... ... ... | 1·37752 |
| Carbonic oxide ... ... ... ... | 0·96716 |
| Carbonic anhydride ... ... ... | 1·52909 |
| Nitrous oxide ... ... ... ... | 1·52951 |

The value obtained for hydrogen upon the same scale was 0·06960; but the researches of M. Leduc and of Prof. Morley appear to show that this number is a little too high.

## THE NORTHAM PEBBLE RIDGE.

THE pebble ridge at Northam is one of the most remarkable examples of littoral drift to be found anywhere round the coast of this country.

It is thus graphically described by Charles Kingsley in "Westward Ho!":—"On this pebble ridge the surges of the bay have defeated their own fury by rolling up in the course of ages a rampart of grey boulder stones, some two miles long, as cunningly curved and smoothed and fitted as if the work had been done by human hands, which protect from the high tides of spring and autumn a fertile sheet of smooth alluvial turf. . . . It was dead calm and yet the air was full of sound—a low deep roar which hovered over downs and broad, salt marsh and river, like the roll of a thousand wheels, the tramp of endless armies, or—what it was—the thunder of a mighty surge upon the boulders of the pebble ridge. . . . The spirit of the Atlantic storm had sent forward the token of his coming in the smooth ground swell which was heard inland two miles away. To-morrow the pebbles, which were now rattling down with each retreating wave, might be leaping to the ridge top and hurled like round shot far ashore upon the marsh by the force of the advancing wave fleeing before the wrath of the western hurricane."

The particulars contained in the following description of this ridge have been obtained during a recent inspection of this part of the coast of North Devon, and from information obtained from the coastguard and others living in the locality.

The boulders which compose the ridge have been derived from the cliffs which surmount the shore of Barnstaple Bay, from Hartland Point to Westward Ho, a distance along the coast of about thirteen miles. These cliffs rise to a height of 350 feet above the level of the sea between Hartland Point and Clovelly, the height then gradually diminishing towards Westward Ho, where they terminate. They are composed principally

[1] Rayleigh and Ramsay, *Phil. Trans.*, vol. clxxxvi. p. 190, 1895.

[1] *Roy. Soc. Proc.*, vol. liii. p. 148, 1893; vol. lv. p. 340, 1894; *Phil. Trans.*, vol. clxxxvi. p. 189, 1895; *Roy. Soc. Proc.*, vol. lix. p. 201, 1896.

of hard carboniferous grit of a dark slate colour, except at the western end, where this rock is interspersed with red sandstone and shale and a few pockets of glacial drift. The beach between the foot of the cliffs and low water consists of rocks cut and furrowed by the action of the sea in perpetually rolling about the large boulders which lie along its surface.

Beyond Westward Ho the estuary of the Taw and the Torridge commences, consisting of a vast expanse of sand bounded by sand dunes.

Large fragments of rocks have in the course of ages been dislodged from the cliffs, the remains of which perpetually rolled about by the waves of the sea during high tides, which here rise to a height of 27 feet, have acted as instruments for grinding their fellows, and battering the cliffs, and so producing the rounded boulders which now strew the beach throughout its whole length for several miles, and a portion of which, drifted along the shore of the bay, have become finally heaped up in the Northam pebble ridge.

In some parts of the cliff indents of considerable size have been cut out, and across these the boulders have collected, and been thrown up into ridges and banks. At Abbotsham, about twelve miles from Hartland, there is such a bank, the top of which is 9 feet above high water of spring tides. This ridge or bank is about 160 feet wide, the boulders of which it is composed varying in size at the top from about 12 inches in length by 4 inches in diameter to pebbles 3 inches in diameter, the largest boulders weighing about 12 lbs., those at the foot reaching to a length of 2 feet and weighing about 70 lbs. Notwithstanding the large size of the boulders of which the bank is composed its sea face is shaped into a ridge and hollow, similar to other pebble ridges, the position of which varies according to the height of previous spring tides. The pebbles left on the shelf or hollow at the spring-tide level average a smaller size than those at the other part of the bank.

The boulders scattered along the beach all lie above the level of low water of neap tides. The general direction of movement is eastwards, but the boulders follow the line of the coast and the set of the flood tide. This direction varies round the bay from eastward to south-east, east again and then north-east, and finally south-east. The direction of the wind which drives the heaviest sea into the bay is from the north-west.

The Northam pebble ridge commences at the termination of the cliffs, and runs in a north north-easterly direction for upwards of two miles across a low flat plain which is below the level of high tides, until it falls into some hummocks of blown sand. It thus forms a natural embankment enclosing a tract of 900 acres of sandy and alluvial grass land which is used for grazing purposes, and also as golf links. After running along the foot of the sand hills for a short distance the pebble bank turns sharply to the south-east up the course of the outfall of the two rivers, the boulders diminishing in size to pebbles and coarse sand. There is an outlying bed of boulders, known as the Pulley, situated some distance from the bank, on the edge of the low-water channel of the river, but these appear to be a fixed deposit which neither increases nor diminishes in size.

The ridge is approximately 180 feet wide at the base and 20 feet high, the top being about 25 to 30 feet wide and 6 feet above high water of spring tides. The boulders on the top of the bank vary in size from about 12 inches in length by 6 inches in diameter to pebbles an inch in diameter, the average size being about 8 inches in length by 4 inches in diameter, the largest being about 12 inches long and weighing from 40 to 50 lbs. At the foot of the bank are to be found boulders measuring from 15 to 18 inches in length and weighing from 100 to 150 lbs. The size of the boulders does not vary much throughout the length of the bank. The greatest collection of small stones appears to be on the shelf or hollow at the level of spring tides, where the pebbles vary from about half an inch to four inches in diameter. Some of the larger boulders have been drifted quite to the far end of the bank.

The boulders consist entirely of the same description of slate-coloured carboniferous grit as the cliffs from Hartland to Abbotsham are composed of, and there can be no doubt that they have drifted from this part of the coast. At the commencement of the ridge there are fairly numerous samples of shale and red sandstone pebbles from the cliffs between Westward Ho and Abbotsham, but these gradually disappear further along the ridge, the softer rock of which they are composed evidently not being able to withstand the constant grinding process produced by the wave action of the tides and wind. From the foot of the bank to low water the beach is covered with sand, which dries from a third of a mile at the south end to three-quarters of a mile at the northern end.

There is a very slow but continuous drift or movement of the boulders along the bank northwards. The progress of the ridge being stopped by the sand hills, the bank has bifurcated at this point, a new or double bank now forming, a circumstance which has occurred within the knowledge of those who have known the bank all their lives.

The boulders composing the ridge are in perpetual motion during the time that the bank is covered by the sea at spring tides. Even in calm weather in summer the whole face of the bank is continually changing under the influence of the wave action of the flood and ebb tide, which is of sufficient force to cause the movement of even large boulders. Observers who have carefully watched this movement and marked individual stones find that they are never in the same place two tides running, and each spring tide leaves its impress in a hollow and ridge at high-water mark.

In heavy on-shore gales these ridges and hollows are obliterated, and the face of the bank is pulled down seaward, the extent to which this is carried depending on the force and duration of the gale. After the storm, and when the height and force of the waves have subsided, the pebbles begin to move back again ; the contour of the bank becomes more steep, and is soon restored to its normal condition.

During the winter at the end of 1896 there was a succession of westerly gales, culminating in a very heavy gale from the north-west. The bank was torn down and so lowered that the waves broke over it and inundated the enclosed land. Some of the largest boulders were thrown over the top of the ridge and hurled a considerable distance inland, where they now remain as a witness to the force of the gale. The disturbance of the boulders was so great under the action of the waves, that after the gale it was found that the base of the bank was moved ten yards inland, the clay bed on which it had rested previously being exposed. A somewhat similar movement took place during a gale about twenty years previously.

The peculiarity of this pebble ridge, and the way in which it differs from ordinary shingle banks, is in the large size of the boulders drifted along the coast, and heaped up by the action of the waves and tides. W. H. WHEELER.

## RANDOM SELECTION.

THIS memoir[1] is the first of a series dealing with the problem of selection, namely the measurement of the changes in the characters of a race, when selection has acted upon any one, two, or more of them. The problem mathematically differs considerably according to the nature of the selection. But in all cases the general result is the same, the selection of any organ, whether by size, variability, or correlation with other organs, changes the sizes, variabilities, correlations of all other organs, whether directly correlated with the first organ, or only indirectly correlated with it owing to correlation with other organs which are correlated with the first organ. (A and C may have no correlation with each other, but both be correlated with B, *e.g.* two parents in the absence of sexual selection and their offspring.) The chief types of selection which have to be treated independently are :—

(i.) *Random Selection* or *Sample Selection.*—The isolation of a group out of a larger population. This will generally have characters divergent from those of the general population, but which form in themselves a correlated system of divergences.

(ii.) *Epidemic Selection.*—Selection which takes place so quickly that the growth or reproduction of the population may be neglected. For example, a severe winter or a pestilence.

(iii.) *Auxetic Selection*, or long-continued selection which allows during its action for growth, but not for reproduction. For example, diseases of childhood.

(iv.) *Gonimic Selection*, or long-continued selection which allows during its action for reproduction. For example, physical and mental qualities, pressure of other populations. These forms of

[1] Contributions to the Mathematical Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation, by Karl Pearson and L. N. G. Filon. (Royal Society, Nov. 25, 1897.)

selection require very different mathematical treatment; it is not at all clear, that they have always been sufficiently distinguished by writers on the theory of evolution. The above paper covers only the ground of the first kind of selection, random selection, but the memoir on epidemic selection is already completed, and the theory of the other cases advanced. The importance of random selection not only arises from the differentiation of species by isolation of small groups from a general population, but also from the fact that every measurement on a population is really a measurement on a more or less extensive random selection or sample. Hence the theory of random selection is also the theory of the probable errors of the frequency constants for any race. It enables us to determine the accuracy with which we have measured the chief racial constants.

Let the frequency-surface giving the distribution of a population with regard to $n$-organs be

$$z=f(x_1\, x_2,\, x_3 \ldots x_n,\, c_1,\, c_2\, c_3 \ldots c_q)$$

where $c_1\, c_2 \ldots c_q$ are the $q$ constants which determine the characters of the population. Then the surfaces for the distribution of the errors in $c_1, c_2 \ldots c_q$ is given approximately by

$$z=z_0 e^{-\frac{1}{2}(a_{11}\, e_1^2+2a_{12}e_1e_2+\ldots)}$$

where

$$a_{vu}=-\iiint \ldots z\, \frac{d^2 \log z}{dc_v dc_u}\, dx_1 dx_2 \ldots dx_n$$

Higher terms can be evaluated if needful; we have then a skew correlation of the system of errors. Approximately the divergences of any random selection from the characters of the general population form in themselves a normally correlated system, and we can predict from a knowledge of the divergence in one character the probable divergences in all the others.

The general formulæ are applied to the problems of

(i.) *The random selection out of a population having* n *normally correlated organs.*

If one character be changed, say the variability of one organ be altered, it is shown how the probable changes in all the other characters may be found; for example, the changes in the correlation of other organs. This is the death-blow to any theory that either variability or correlation can be constant for local races.

(ii.) *Skew Variation*, for all the three types discussed in a previous memoir.

Criteria are obtained for determining when skewness is significant; when the mode really diverges from the mean, &c.

In many cases in which the normal curve of errors is used, the skewness is really significant, and thus many of the results used are illegitimate. For example, personal equation is generally sensibly skew, curves for size of organs during growth, and nearly all cases of botanical distribution.

These points are illustrated in the memoir by three numerical examples:—

(I.) Müllerian glands in the legs of swine; data from the observations of two American naturalists. The skewness can be determined with less than 5 per cent. of probable error. It is therefore significant, and the use by the above-mentioned biologists of the ordinary theory of errors is in this case to be deprecated.

(II.) Enteric fever. Skewness is known to 1 per cent. of probable error.

The effect of raising mean age, or altering the incidence, &c. on the character of the disease follows at once from the tables given.

(III.) Stature during growth; a critical case, taken because the distribution is almost normal. The skewness is, however, probably significant, and the influence indicated of random selection on stature during growth is in accordance with experience.

## *MODIFICATION OF THE GREAT LAKES BY EARTH MOVEMENT.*[1]

THE history of the Great Lakes practically begins with the melting of the Pleistocene ice-sheet. They may have existed before the invasion of the ice, but if so their drainage system is unknown. The ice came from the north and north-east, and, spreading over the whole Laurentian basin, invaded the drainage districts of the Mississippi, Ohio, Susquehanna and Hudson. During its wandering there was a long period when the waters were ponded between the ice front and the uplands south of the Laurentian basin, forming a series of glacial lakes whose outlets were southward through various low passes. A great stream from the Erie basin crossed the divide at Fort Wayne to the Wabash river. A river of the magnitude of the Niagara afterwards flowed from the Michigan basin across the divide at Chicago to the Illinois river; and still later the chief outlet was from the Ontario basin across the divide at Rome to the Mohawk valley.

The positions of the glacial lakes are also marked by shore-lines, consisting of terraces, cliffs, and ridges, the strands and spits formed by their waves. Several of these shore-lines have been traced for hundreds of miles, and wherever they are thoroughly studied it is found that they no longer lie level, but have gentle slopes towards the south and south-west. Formed at the edges of water surfaces, they must originally have been level, and their present lack of horizontality is due to unequal uplift of the land. The region has been tilted towards the south-south-west. The different shore-lines are not strictly parallel, and their gradients vary from place to place, ranging from a few inches to three or four feet to the mile.

### *Early History of the Lakes.*

The epoch of glacial lakes, or lakes partly bounded by ice, ended with the disappearance of the ice-field, and there remained only lakes of the modern type, wholly surrounded by land. These were formed one at a time, and the first to appear was in the Erie basin. It was much smaller than the modern lake, because the basin was then comparatively low at the north-east. Instead of reaching from the site of Buffalo to the site of Toledo, it extended only to a point opposite the present city of Erie, and it was but one-sixth as large as the modern lake. Since that time the land has gradually risen at the north, canting the basin towards the south, and the lake has gradually encroached upon the lowlands of its valley.

The next great lake to be released from the domination of the ice was probably Ontario, though the order of precedence is here not equally clear. Before the Ontario valley held a land-bound lake it was occupied by a gulf of the ocean. Owing to the different attitude of the land, the water surface of this gulf was not parallel to the present lake surface, but inclined at an angle. In the extreme north-east, in the vicinity of the Thousand Islands, the marine shores are nearly 200 feet above the present water level, but they descend southward and westward, passing beneath the lake level near Oswego, and towards the western end of the lake must be submerged several hundred feet. This condition was of short duration, and the rising land soon divided the waters, establishing Lake Ontario as an independent water body. The same peculiarity of land attitude which made the original Erie a small lake served to limit the extent of Ontario, but the restriction was less in amount because of the steeper slopes of the Ontario basin. Here again the southward tilting of the land had the effect of lifting the point of outlet and enlarging the expanse of the lake.

There is some reason to think that the upper lakes, Huron, Michigan and Superior, were at first open to the sea, so as to constitute a gulf, but the evidence is not so full as could be desired. When the normal lacustrine condition was established they were at first a single lake instead of three, and the outlet, instead of being southward from Lake Huron, was north-eastward from Georgian bay, the outlet river following the valleys of the Mattawa and Ottawa to the St. Lawrence. The triple lake is known to us chiefly through the labours of Mr. F. B. Taylor, who has made extensive studies of its shore-line. This line, called the Nipissing shore-line, is not wholly submerged, like the old shores of lakes Erie and Ontario, but lies chiefly above the present water surfaces. It has been recognised at many points about Lake Superior and the northern parts of lakes Huron and Michigan, and measurements of its height show that its plane has a remarkably uniform dip, at 7 inches per mile, in a south-south-west direction, or, more exactly, S. 27° W. The southward tilting of the land, involving the uplift of the point of outlet, increased the capacity of the basin and the volume of the lake, gradually carrying the coast-line southward in Lake Huron and Lake Michigan until finally it reached the low pass at Port Huron, and the water overflowed *viâ* the St. Clair and Detroit channels to Lake Erie. The outlet by way of the Ottawa was then abandoned, and a continuance of the

[1] Abridged from a paper, by Prof. G. K. Gilbert, in the *National Geographic Magazine* (September 1897).

uplift caused the water to slowly recede from its northern shores. This change after a time separated Lake Superior from the other lakes, bringing the St. Marys river into existence, and eventually the present condition was reached.

These various changes are so intimately related to the history of the Niagara river that the Niagara time estimates, based on the erosion of the gorge by the cataract, can be applied to them. Lake Erie has existed approximately as long as the Niagara river, and its age should probably be reckoned in tens of thousands or hundreds of thousands of years. Lake Ontario is much younger. All that can be said of the beginning of Great Lake Nipissing is that it came long after the beginning of Lake Erie, but the date of its ending, through the transfer of outlet from the Mattawa to the St. Clair, is more definitely known. That event is estimated by Taylor to have occurred between 5000 and 10,000 years ago.

The lake history thus briefly sketched is characterised by a progressive change in the attitude of the land, the northern and north-eastern portions of the region becoming higher, so as to turn the waters more and more towards the south-west. The latest change, from Great Lake Nipissing to Great Lakes Superior, Michigan and Huron, involving an uplift at the north of more than 100 feet, has taken place within so short a period that we are naturally led to inquire whether it has yet ceased. Is it not probable that the land is still rising at the north, and the lakes are still encroaching on their southern shores? Dr. J. W. Spencer, who has been an active explorer of the shore-lines of the glacial lakes, and has given much study to related problems, is of opinion that the movements are not complete, and predicts that they will result in the restoration of the Chicago outlet of Lake Michigan and the drying of Niagara.

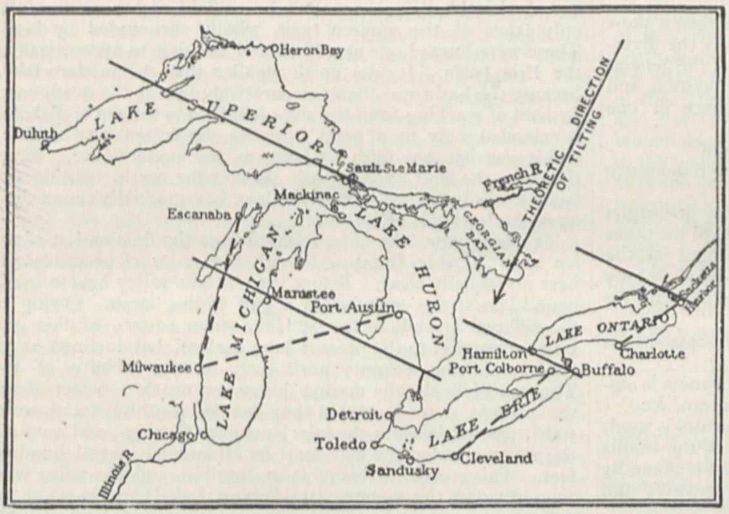



FIG. 1.—Map of the Great Lakes, showing pairs of gauging stations and isobases of outlets. The isobases are marked by full lines. Broken lines show the pairs of stations.

*Measurements of Changes in the Shore-lines.*

The importance of testing this question by actual measurements was impressed upon me several years ago, and I endeavoured to secure the institution of an elaborate set of observations to that end. Failing in this, I undertook a less expensive investigation, which began with the examination of existing records of lake height as recorded by gauge readings, and was continued by the establishment of a number of gauge stations in 1896.

If the volume of a lake were invariable, and if its water were in perfect equilibrium under gravity, its surface would be constant and level, and any variation due to changes in the height of the land could be directly determined by observations on the position of the water surface with reference to the land; but these conditions are never realised in the case of the Great Lakes, where the volume continually changes and the water is always in motion. The investigator therefore has to arrange his measurements so as to eliminate the effect of such changes.

The various oscillations of the water, though differing widely in amplitude, rate and cause, yet coexist, and they make the actual movement of the water surface highly complex. The complexity of movement seriously interferes with the use of the water plane as a datum level for the measurement of earth movements, and a system of observations for that purpose needs to be planned with much care. The main principles of such a system are, however, simple, and may readily be stated. The most important is that the direct measurement of the heights of individual points should not be attempted, but comparison should always be made between two points, their relative height being measured by means of the water surface used as a levelling instrument.

It will not be necessary to give here the details of observation and computation, as they are fully set forth in a paper soon to be printed by the U.S. Geological Survey, but the general scope of the work may be briefly outlined. As the tilting shown by the geological data was towards the south-south-west, stations were, so far as possible, selected to test the question of motion in that direction. The most easterly pair were Sacketts Harbour and Charlotte, New York, connected by the water surface of Lake Ontario (Fig. 1). From observations by the U.S. Lake Survey in 1874, it appeared that a bench mark on the old lighthouse in Charlotte was then 18·531 feet above a certain point on the Masonic Temple in Sacketts Harbour. In 1896 the measurement was repeated, and the difference found to be 18·470 feet, the point at Sacketts Harbour having gone up, as compared to the point at Charlotte, 0·061 foot, or about three-fourths of an inch. Similarly it was found that between 1858 and 1895 a point in Port Colborne, at the head of the Welland Canal, as compared to a point in Cleveland, Ohio, rose 0·239 foot, or nearly three inches. Between 1876 and 1896 a point at Port Austin, Michigan, on the shore of Lake Huron, as compared to a point in Milwaukee, on the shore of Lake Michigan, rose 0·137 foot, or one and one-half inches; and in the same period a point in Escanaba, at the north end of Lake Michigan, as compared to the same point in Milwaukee, rose 0·161 foot, or about two inches.

There is not one of these determinations that is free from doubt; buildings and other structures on which the benches were marked may have settled; mistakes may have been made in the earlier levelling, when there was no thought of subjecting the results to so delicate a test; and there are various other possible sources of error to which no checks can be applied. But the fact that all the measurements indicate tilting in the direction predicted by theory, inspires confidence in their verdict.

The stations of the several pairs are at different distances apart, the directions of the lines connecting them make various angles with the theoretical direction of tilting, and the time intervals separating the measurements are different. To reduce the results to common terms, I have computed from each the rate of tilting it implies in the theoretical direction, S. 27° W., and determined the change in relative height of the ends of a line 100 miles long during a century.

Compared in this way, the results are remarkably harmonious, the computed rates of tilting ranging only from 0·37 foot to 0·46 foot per 100 miles per century; and in view of this harmony it is not easy to avoid the conviction that the buildings are firm and stable, that the engineers ran their level lines with accuracy, that all the various possible accidents were escaped, and that we have here a veritable record of the slow tilting of the broad lake-bearing plain.

The computed mean rate of tilting, 0·42 foot per 100 miles per century, is not entitled to the same confidence as the fact of tilting. Its probable error, the mathematical measure of precision derived from the discordance of the observational data, is rather large, being one-ninth of the whole quantity measured. Perhaps it would be safe to say that the general rate of tilting, which may or may not be uniform for the whole region, falls between 0·30 and 0·55 foot.

*Future of the Great Lakes.*

The geographical effects of the tilting are of scientific and economic importance. Evidently the height of lake water at a lake's outlet is regulated by the discharge, and is not affected by slow changes in the attitude of the basin; but at other points of the shore the water advances or retreats as the basin is tipped. Consider, for example, Lake Superior. On the map (Fig. 1) a line has been drawn through the outlet at the head of St. Marys River in a direction at right angles to the direction of tilting. All points on this line, called the *isobase* of the outlet, are raised or lowered equally by the tilting, and are unchanged with reference to one another. All points south-west of it are lowered, the amount varying with their distances from the line, and all points to the north-east are raised. The water, always holding its surface level, and always regulated in volume by the discharge at the outlet, retreats from the rising north-east coasts, and encroaches on the sinking south-west coasts. Assuming the rate of tilting to be 0·42 foot per 100 miles per century, the mean lake level is rising at Duluth 6 inches per century and falling at Heron Bay 5 inches. Where the isobase intersects the north-western shore, which happens to be at the international boundary, there is no change.

Lake Ontario lies altogether south-west of the isobase of its outlet, and the water is encroaching on all its shores. The estimated vertical rise at Hamilton is 6 inches per century. The whole coast of Lake Erie also is being submerged, the estimated rate at Toledo and Sandusky being 8 or 9 inches per century.

The isobase of the double Lake Huron-Michigan passes south-west of Lake Huron and crosses Lake Michigan. All coasts of Lake Huron are therefore rising as compared to the outlet, and the consequent apparent lowering of the mean water surface is estimated at 6 inches per century for Mackinac, and at 10 inches for the mouth of the French river on Georgian Bay. In Lake Michigan the line of no change passes near Manistee, Michigan. At Escanaba the estimated fall of the water is 4 inches per century; at Milwaukee the estimated rise is 5 or 6 inches, and at Chicago between 9 and 10 inches.

These slow changes of mean water level are concealed from ordinary observation by the more rapid and impressive changes due to variations of volume, but they are worthy of consideration in the planning of engineering works of a permanent character, and there is at least one place where their influence is of moment to a large community. The city of Chicago is built on a smooth plain little above the high-water level of Lake Michigan. Every decade the mean level of the water is an inch higher, and the margin of safety is so narrow that inches are valuable. Already the older part of the city has lifted itself several feet to secure better drainage, and the time will surely come when other measures of protection are imperatively demanded.

Looking to the more distant future, we may estimate the date at which the geographical revolution, prophesied by Spencer, will occur. Near Chicago, as already mentioned, is an old channel made by the outlet of a glacial lake. The bed of the channel at the summit of the pass is about 8 feet above the mean level of Lake Michigan and 5 feet above the highest level. In 500 or 600 years (assuming the estimated rate of tilting) high stages of the lake will reach the pass, and the artificial discharge by canal will be supplemented by an intermittent natural discharge. In 1000 years the discharge will occur at ordinary lake stages, and after 1500 years it will be continuous. In about 2000 years the discharge from Lake Michigan-Huron-Erie, which will then have substantially the same level, will be equally divided between the western outlet at Chicago and the eastern at Buffalo. In 2500 years the Niagara river will have become an intermittent stream, and in 3000 years all its water will have been diverted to the Chicago outlet, the Illinois river, the Mississippi river, and the Gulf of Mexico.

## FORESTS AND RAINFALL.[1]

CAN it be possible that the cutting away of forests affects the amount of precipitation in any locality? To many, no doubt, this question will seem easy of answer; but we find the results of study by no means reassuring, and recent investigations have led to almost diametrically opposite conclusions, depending, somewhat at least, upon the feeling of the writer. When we reflect that our rain storms are of very wide extent, oftentimes over 1000 miles in diameter, and may take their origin and bring their moisture from distances of 1000 miles or more, the thought that man, by his puny efforts, may change their action, or modify it in any manner, seems ridiculous in the extreme.

It has been well established that forests have a most important bearing upon the conservation of rainfall; that the forest floor permits a seepage of water to the source of springs, and thus maintains their steady flow; that they hold back the precipitation that falls, especially in the form of snow, thus preventing or ameliorating the effects of dangerous freshets. There is not the slightest doubt of their great importance to the welfare of man, but all these facts do not affect the question of their influence upon precipitation. The following paper is prepared from the standpoint of a meteorologist, and is an attempt to present facts.

### *The Historical Argument.*

Formerly the historical argument was a favourite one. I quote one of these: "It is a familiar fact that there are many regions in Asia and southern Europe, once exceedingly fertile and densely populated, that are now utterly sterile and desolate. The country bordering on the Euphrates and portions of Turkey, Greece, Egypt, Italy and Spain are now incapable of cultivation from lack of rain due to deforestation." The most fertile of all provinces in Bucharia was that of Sogd. Malte Brun said, in 1826, "For eight days we may travel and not be out of one delicious garden." In 1876 another writer says of this same region: "Within thirty years this was one of the most fertile spots of central Asia, a country which, when well wooded and watered, was a terrestrial paradise. But within the last twenty-five years a mania of clearing has seized upon the people, and all the great forests have been cut away, and the little that remained was ravaged by fire during a civil war. The consequences followed quickly, and this country has been transformed into a kind of arid desert. The water-courses are dried up and the irrigating canals are empty." It has also been said that in the older settled portions of New England and the Middle States there are arid hills and worn-out fields, due to the falling off of precipitation from the cutting away of the forest growth. Such quotations and statements might be made to fill a large volume. Without more precise data as to rainfall it would be hazardous to conclude that we have here a case of cause and effect. It is certain that the fertility of these regions in ancient times was due to stupendous irrigating devices and canals, and when these were neglected, through wars and other untoward circumstances, the fertility necessarily ceased. It is certain that there are ruins of enormous irrigating ditches and canals in Babylonia, where history indicates that there was once a teeming population and great fertility, but where now only a sandy desert greets the eye.

### *Constancy of Rainfall.*

It has been said that where our densest forests are found there we have the greatest precipitation. There is no way whereby we can see that such forests would have started unless favoured by rainfall, so that the presence of the forest rather indicated the earlier occurrence of practically the same rainfall as at present. Meteorologists are agreed that there has been practically no change in the climate of the world since the earliest mention of such climates. Plants found in mummy cases in Egypt that were plucked thousands of years ago show the same size as those now found in that land. The "early and the latter rains" are experienced in Palestine to-day just as they were four thousand years ago. Jordan "overflows all its banks" to-day, in February, precisely as it did in Joshua's day. When we come down to recent times and to the records of rainfall measured in New England for more than one hundred years, or, at least, before and since the forests were cut, we find a constancy in the rainfall which shows its entire independence of man's efforts. Here it should be noted that totally barren lands of any extent, in New England for example, are to be found only in imagination. Even where the forest has been cut away mercilessly there springs up a growth of sprouts which covers the ground, and answers almost the same purpose in causing rainfall (if there is any effect of that kind) as the forest. Even where land is entirely cleared of a forest we have at times the green pasture, and at others still heavier crops which leave the ground anything but a sandy waste.

### *Rainfall Measurements in Forests and Open Fields.*

But the strongest argument adduced in the past to show the influence of forest on rainfall has existed in a comparison between rain-gauge measures in the forest and the open field

[1] A paper by Prof. H. A. Hazen, presented at the annual meeting of the American Forestry Association at Nashville, Tenn., September 22. (Abridged from the *Monthly Weather Review*.)

Such records have been made for more than thirty years in France and Germany, and surely we must have here, if anywhere, a sufficient proof of a forest's influence.

Admitting that we have perfect instruments and careful observers, there still remains a most serious doubt as to the immediate environment of each gauge and as to the possibility of a direct comparison. It is probable that no two gauges 2000 feet apart can be placed so as to catch the same amount of rain, though to all appearances the exposure is faultless in each case.

Extreme caution is therefore needed in arriving at conclusions from comparisons between gauges in forests and in the open. One of the best of all researches in this line has been conducted at Nancy, in France. Within a distance of five or six miles there have been four stations established. At Nancy in the open, and at Belle-Fontaine in the forest; and, 500 feet higher vertically, Amance (open) and Cinq-Tranchées (forest). At Nancy and Belle-Fontaine the observations extend over twenty-five years. A comparison of the records in groups of eight, eight, and nine years was made, with the result that while the first eight years showed a very slight excess in the forest rainfall over that in the open field, in the last nine years (including 1894, last published) the open station showed a little more rain than the forest station. These observations were made with particular care, for the purpose of exactly determining the influence, and may be relied on if the environments of the gauges were comparable. At Amance (open) and Cinq-Tranchées (forest) the observations have not been quite so regular, though there are twenty-five full years of records at these two stations, but not the same years as at the other stations. The comparison in this case makes the rainfall more than 20 per cent. greater in the forest than in the open. It should be borne in mind, however, that these two stations are on an eminence, and are not strictly comparable, and this result cannot vitiate that at the two other stations, which shows no effect.

In Germany we have a rather remarkable record of a slightly different character. Lintzel is a station on the Luneburg Heath, which began to be planted with trees in 1887, at the rate of 1000 to 1500 acres a year, and in a few years over 8000 acres were covered. In the midst of this forest is the meteorologic station in an open field of some seventy-five acres. Before planting the forest, 97 per cent. of the surface was field, meadow, or heath, and afterwards 80 per cent. was forest and 20 per cent. was roads, open field, and heath. Around this station, pretty evenly distributed, and within fifty miles, there are thirteen rainfall stations which have been carefully established, and presumably are comparable with the Lintzel station in the midst of the growing forest. There are no means of knowing whether any of these stations have been changed or not, but for our purpose we may consider the material homogeneous, and treat it accordingly. Records from 1882 to 1896 (fifteen years) are available. Charts were prepared for each year showing the ratio between the Lintzel record and that at each station of the thirteen. The results do not show that the afforestation has had any appreciable effect upon the precipitation; in 1884 the ratio was 101, while in 1893, nine years later, it was 96. It is probable, however, that no definite and unassailable result can ever be obtained either by the method adopted in France or this later one in Germany. The rainfall is so variable within a distance of even a mile or two; and it is so difficult, if not impossible, to obtain similar environments at all the stations, that no decisive result can be obtained. It will be readily seen that the multiplication of stations will do no good, and, above all, that the observation of rainfall under trees in a forest is absolutely useless for any such discussion or study as this.

*Need of Further Evidence.*

It seems probable that if two or three lines of stations could be established a mile or two apart on four sides of an enormous forest, each line to have a dozen stations or so, about 3000 feet apart, four of the stations to be outside of the forest, and the others each in a large cleared space of at least two acres extent in the forest, something decisive might be obtained. It should be noted, however, that from the evidence already accumulated there would be very little to be gained by a further study of the question. It is certain that the effect, if there be one, is almost inappreciable. The favouring conditions over the forest are balanced by those not favouring, and the integrated effect is practically the same in the two cases.

Prof. H. F. Blanford determined from a most careful series of records, from which all known errors had been eliminated, that the forest had a tendency to give 2 per cent. more rain than contiguous open fields. That is, if an open place had 50 inches of rain in a year, a near-by forest would have only 51 inches, which is practically inappreciable.

It would be an interesting study to select all those cases in experiments in forest and near-by fields in which the wind was blowing either from the forest to the field, or *vice versâ*. It is evident that if there is any effect on rainfall by the forest, it would be vitiated, if not exactly reversed by such winds.

There is a class of visual observations which seem to show an effect upon rainfall by the forest. Probably many have seen heavy clouds passing over a plain, but which only precipitated as they passed over a forest. Also in a hilly region it is a frequent phenomenon that fog and low-lying cloud hover near a forest, and not over an open plain. One also notes very often, in passing into a forest on a damp day, that the trees drip moisture, possibly condensed from moisture evaporated from the damp earth underneath. Observations of this nature, however, cannot ordinarily be checked by instrumental means, but show in a general way that the forest tends to conserve vapour and moisture which in the case of the open field would be diffused into the atmosphere.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. G. H. RENDALL, the Principal of University College, Liverpool, has been appointed Head-Master of Charterhouse School.

SIR JOHN GORST, in the course of an address at Bristol on Thursday last, is reported by the *Times* to have said that the promotion of technical education was confronted by two obstacles—the backward condition of elementary education and the want of organisation in the provision of secondary education. A good sound system of elementary education must be the groundwork for higher education, and he urged reform of the system which at present relieved children from compulsory attendance when inadequately equipped. The improvement of the organisation of secondary schools was really a matter for the people themselves. There was nothing to prevent technical instruction committees from becoming thoroughly representative and effective organisations.

THE most satisfactory point to us in the Report just issued by the Oxford University Extension Delegacy refers to the Extension College at Reading. The college is doing excellent work, more particularly in agriculture, and has amply justified its existence. New buildings are, however, imperatively needed, and in response to an appeal for 12,000*l*., 9,000*l*. has already been promised, and the new wing has been begun. The building scheme, planned four years ago, will be completed by next summer, and H.R.H. the Prince of Wales has promised to perform the opening ceremony. The educational work of the college has been attended with great success during the past year. With regard to the courses of lectures delivered under the auspices of the Delegacy during the year 1896–97, we notice that out of a total of 146 courses, only nineteen were on scientific subjects.

IN the course of a presidential address recently delivered before the Kansas Academy of Sciences, Prof. S. W. Williston severely criticised the system of education which makes language studies compulsory, and all, or nearly all, the sciences optional. Many educationists will find themselves in agreement with the following opinions expressed by Prof. Williston:—"I claim broadly and emphatically that the natural sciences, any or all of them, are as valuable and as necessary as pure cultural studies as are the languages; that intelligent and successful study of them will do as much, if not more, in making the student a broad man, a successful man, as will the study of Latin or Greek. And they will do more in making him an honest man. Nowhere in all the broad field of knowledge will he learn better to think exactly than in the natural sciences. Nowhere will he be more impressed with the importance of truth for truth's sake. . . . Were I, then, to say what the universities and colleges ought to do, it would be this: make all the ancient language requirements for admission optional, and demand as much preparation in the physical and biological sciences as in the foreign languages. The preparation in English should be made far more rigorous and thorough. In the college course, if anything besides English is required, and I think there should be, I would have the natural science as necessary a part of the education as language and mathematics. I would not have it possible for a student to graduate from the college without having studied, and thoroughly studied, mathematics as far as trigonometry, at least one foreign language, and at least one physical and one biological science. And I do not mean a few weeks of study in any of these branches, but exhaustive, careful, critical study. The methods of study in all these branches are diverse, and are absolutely essential for symmetrical mind-building."

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society,** November 25.—"Further Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-Mother." By Walter Heape, M.A., Trinity College, Cambridge.

In 1890 an experiment was recorded (*Roy. Soc. Proc.*, vol. xlviii.), designed to show that it is possible to make use of the uterus of one variety of rabbit as a medium for the growth and complete fœtal development of fertilised ova of another variety of rabbit. The experiment was further undertaken in order to determine what effect, if any, a uterine foster-mother would have upon her foster-children, and whether or not the presence, during development, of foreign ova in the uterus of a mother would affect offspring of that mother present in the uterus at the same time. In this experiment, two fertilised ova obtained from an Angora doe rabbit which had been inseminated thirty-two hours previously by an Angora buck, were inserted into the fallopian tube of a Belgian Hare doe, which had been inseminated three hours before by a buck of the same breed as herself; and in due course the Belgian Hare doe littered six young, four of which were Belgian Hares, while the other two were Angoras. This year experiments were made with Dutch and Belgian Hare rabbits, and the method adopted was the same as that described above, the result being that the Belgian Hare foster-mother gave birth to seven young, of which five were Belgian Hares and two were apparently Dutch. Both these Dutch young were, however, irregularly marked, and it appeared possible, after all, either (1) that the Belgian Hare foster-mother had influenced the Dutch fertilised ova, or (2) that these two young were really a cross between Dutch and Belgian Hare.

In order to test the first of these possibilities, the same Dutch buck was put to a tried, thoroughbred Dutch doe, and she produced a litter, every one of which was badly marked, thus showing that the bad marking of the foster-children can be justly attributed to their father's influence. The second possibility was more difficult to test. A cross between the Dutch buck and the Belgian Hare foster-mother was obviously possible, for when the foreign Dutch segmenting ova were introduced into the fallopian tube of the Belgian Hare foster-mother, they were still surrounded by spermatozoa from the Dutch buck, which were still alive, though failing in vigour. But the Belgian Hare doe had been inseminated by a Belgian Hare buck just before the operation, and the spermatozoa from this buck would arrive at the end of the fallopian tube before ovulation took place; it would be at least twenty-four hours younger than the foreign Dutch spermatozoa, and both more vigorous and in far greater numbers than the latter. The possibilities are distinctly in favour of the host of younger and more vigorous Belgian Hare spermatozoa beating the few older and less vigorous, foreign, Dutch spermatozoa in the struggle for the Belgian Hare ova; but, at the same time, it is possible that the latter won. The only way to test this at all seemed to be by crossing the same Dutch buck with Belgian Hare does, and comparing the offspring of such crosses with the young foster children. This was done, and two Belgian Hare does each produced, in consequence, five young. Of these, three were Belgian hares splashed with white, one was black and white, three were fawn or fawn and white (the fawn being mixed with a delicate bluish dun shade), and three were thoroughbred Belgian Hares. The father's influence was seen in the introduction of white and in the fawn and dun colours. None of the young, however, at all closely resembled the Dutch breed.

With regard to the foster-children, one of them died at an early age, but the second lived, and is now more typically Dutch than it was when younger; it is coloured and shaped remarkably like the Dutch doe from which the foreign fertilised ova were obtained. The remarkable likeness is in itself very strong evidence of the origin of this young one, and when considered in conjunction with the results obtained by crossing the Dutch buck with Belgian Hare does, there can be little doubt it was derived from Dutch parents. This result, supported by the result obtained in 1890, is greatly in favour of the contention, that it is possible to make use of a uterine foster-mother, and to do so without thereby influencing any of the young which are nourished by her.

It is worthy of notice, if the above is true, that in case telegony be actually demonstrated, the characteristics of a primary husband transmitted to the offspring got by a secondary husband, can only be so transmitted through the ova of the mother.

"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." By Karl Pearson, F.R.S., and L. N. G. Filon, University College, London.

A brief indication of the nature of the contents of this paper is given on p. 210.

December 9.—"On the Calculation of the Coefficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electromagnetic Force between a Helical Current and a Uniform Coaxial Circular Cylindrical Current Sheet." By J. Viriamu Jones, F.R.S.

**Zoological Society,** December 14.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Vice-President, in the chair.—Mr. G. A. Boulenger, F.R.S., offered some further remarks upon the Siluroid Fish, *Vandellia cirrhosa*.—A communication was read from Dr. E. A. Goeldi, "On *Lepidosiren paradoxa* from the Amazons." This memoir treated of the geographical distribution of the *Lepidosiren* on the Amazons, and of its external structure and dimensions, and gave an account of its habits in a natural and captive state.—Mr. J. Graham Kerr gave an account of his recent expedition, along with Mr. Budgett, to the Chaco of Paraguay in quest of *Lepidosiren*: and made remarks on its habits as there observed. Mr. Kerr also gave a general account of the early stages of its development, drawing special attention to the presence in the larva of external gills and a sucker similar to those of the Amphibia.—A communication was read from Dr. A. G. Butler, containing a list of thirty-three species of butterflies obtained by Mr. F. Gillett in Somaliland during the present year, and giving the dates of the capture of the specimens and their localities.—Mr. Oldfield Thomas read a paper entitled "On the Mammals obtained by Mr. A. Whyte in North Nyasaland, and presented to the British Museum by Sir H. H. Johnston, K.C.B.; being a fifth contribution to the Mammalogy of Nyasaland." This memoir contained notes on sixty-one species of Mammals, four of which were characterised as new, viz. *Macroscelides brachyrhynchus malosæ*, *Crocidura lixa*, *Myosorex soulla*, and *Graphiurus johnstoni*.—A communication was read from the Rev. O. Pickard Cambridge, F.R.S., describing a new genus and species of Acaridea (*Eatonia scopulifera*) from Algeria.—A communication by Mr. J. Stanley Gardiner, "On some collections of corals of the family *Pocilloporidæ* from the South-west Pacific Ocean," was read by the author. Twenty species of the genus *Pocillopora* and one of the genus *Seriatopora* were enumerated and remarked upon, five species of the former genus being described as new, viz. *Pocillopora septata*, *P. obtusata*, *P. coronata*, *P. rugosa*, and *P. glomerata*.—Mr. W. E. de Winton gave an account of a collection of Mammals from Morocco, made by Mr. E. Dodson on behalf of Mr. J. I. S. Whitaker. Twenty-one species were enumerated as represented in the collection, of which the following were described as new: *Crocidura whitakeri*, *Mus peregrinus*, and *Lepus atlanticus*.

### DUBLIN.

**Royal Dublin Society,** November 17.—Dr. F. T. Trouton, F.R.S., in the chair.—Dr. G. Johnstone Stoney, F.R.S., presented a paper upon atmospheres upon planets and satellites (see p. 207).—Mr. W. E. Wilson, F.R.S., read a paper upon the apparent cometary nature of the spiral nebula in Canes Venatici. The paper was illustrated by a remarkably fine photograph of the nebula taken in February 1897, by the author.—Dr. F. T. Trouton read a paper upon the arrangement of the crystals of certain substances on solidification.—Prof. A. C. Haddon presented a paper upon the Actiniaria of Torres Straits. This account of the Actiniaria is based mainly on the collections made by the author in 1888–9, supplemented by descriptions published by Mr. Saville-Kent in his works "The Great Barrier Reef of Australia" and "The Naturalist in Australia." In order to render the paper more complete, allusions are made in it to genera which are not recorded from Torres Straits. In a second paper, Prof. Haddon described a new species of Actiniaria from Oceania—*Phellia Sollasi*. This was collected by Prof. Sollas in the lagoon at Funafuti, Ellice Group, W. Pacific, in 1896.—The following objects were exhibited at this meeting: The Coccoliths of Dublin Bay, by Mr. H. H. Dixon, and Prof. J. Joly, F.R.S.—A collection of economic plant products from the Gold Coast, by Prof. T. Johnson.

ST. LOUIS.

**Academy of Science**, December 6.—Mr. Julius Hurter exhibited specimens of a considerable number of reptiles and batrachians, mostly of southern origin, which had been collected by him during the past season, and were additions to the known fauna of Missouri. Among the more interesting additions were the cotton-mouth moccasin, the banded water snake, Holbrook's water snake, the little brown snake, the Louisiana mud turtle, the chestnut-backed salamander (first detected west of the Mississippi River by Mr. Colton Russell), and the marbled salamander.—Mr. H. von Schrenk exhibited a series of specimens and drawings illustrating some of the injuries inflicted on the trees of St. Louis by the tornado of May 1896, showing not only the formation of double twig elongation and growth rings, but the exfoliation of the bark and the consequent drying out of 50 per cent. or more of the wood through the trunk and branches, in several species.

NEW SOUTH WALES.

**Linnean Society**, October 27.—Prof. J. T. Wilson, President, in the chair.—Descriptions of new species of Australian Coleoptera, Part 4, by Arthur M. Lea. Thirty-four species, principally belonging to the *Curculionidæ*, were described as new; with critical notes and remarks on synonymy.—On the lizards of the Chillagoe district, North Queensland, by Dr. R. Broom. Twenty-three species were collected during a six months' residence at Muldiva, seventy miles west of Herberton, a district in which during eight months of the year (April–December) as a rule there is practically no rain. A species of *Lygosoma* was described as new.—On a *Trachypterus* from New South Wales, by J. Douglas Ogilby. In this paper the author gave a detailed description of a young example washed ashore near Newcastle, and reviewed at length our present knowledge of the genus in the south-western Pacific.—Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia, No. 5, by J. J. Fletcher. The present contribution is based upon the examination of collections from Tasmania and West Australia. In the British Museum Catalogue (second edition) seven (? eight) species are attributed to Tasmania, and fourteen to West Australia. Three additional species are now recorded for the former Colony, and six for the latter, including an undescribed species of *Crinia* belonging to the group having the abdominal surface non-granulate.—Mr. Froggatt exhibited a number of scale insects (*Eriococcus coriaceus*, Mask.), upon a twig of Eucalyptus, among which had been placed a great number of the eggs of the scale eating moth *Thalpochares coccophaga*, Meyr. The eggs are pale pink, circular, and beautifully ribbed. The scales were infested with the larvæ of *Cryptolæmus montrouzieri*, Muls., a useful small black ladybird beetle. Both these enemies of *Eriococcus* are of great economic value, as the moth larvæ have now taken to eating the olive scale (*Lecanium oleæ*, Sign.), and the ladybird beetle is bred both in New Zealand and America. Also living specimens of our largest white ant, *Calotermes longiceps*, Froggatt, which were taken out of a log of fire-wood, and had already been in captivity for over two months.

## DIARY OF SOCIETIES.

*MONDAY*, JANUARY 3.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Standard Methods of Tanning Analysis as adopted by the International Association of Leather Trades Chemists, with Remarks thereon: Prof. H. R. Procter and Dr. J. G. Parker.—Extraction of Tanning Materials at various Temperatures: Dr. J. G. Parker.—Neatsfoot Oil: J. H. Coste and E. J. Parry.

VICTORIA INSTITUTE, at 4.30.—Ancient Civilizations: Rev. John Tuckwell.

*TUESDAY*, JANUARY 4.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

ROYAL VICTORIA HALL, at 8.30.—Coal: W. F. Rudler.

*WEDNESDAY*, JANUARY 5.

GEOLOGICAL SOCIETY, at 8.—On the Structure of the Davos Valley: A. Vaughan Jennings.—Sections along the Lancashire, Derbyshire, and East Coast Railway, between Lincoln and Chesterfield: C. Fox-Strangways.

*THURSDAY*, JANUARY 6.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

*FRIDAY*, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 8.—A Brief Account of the Excursions in the Urals, down the Volga, in the Caucasus, &c., made in connection with the Interntional Geological Congress held in Russia, August–September, 1897: L. L. Belinfante.

*SATURDAY*, JANUARY 8.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

## BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—L'Electro-chimie: A. Minet (Paris, Gauthier-Villars).—Introduction to the Study of Organic Chemistry: J. Wade (Sonnenschein).—Natürliche Schöpfungs-Geschichte: Prof. E. Haeckel, 2 Vols., Neunte Umgearbeitete Auflage (Berlin, Reimer).—Notes on Carpentry and Joinery: T. J. Evans, Vol. 1 (Chapman).—What is Life?: F. Hovenden (Chapman).—The Collected Mathematical Papers of Arthur Cayley, Vol. xiii. (Cambridge University Press).—Physikalisch-Chemische Propaedentik: Prof. H. Griesbach, Zweite Hälfte, 2 Liefg (Leipzig, Engelmann).

PAMPHLETS.—Magnetic and Pendulum Observations: G. R. Putnam (Boston, Mass.).—Hand-Guide to the Botanic Gardens, Buitenzorg (Batavia, Kolff).

SERIALS.—Traité Encyclopédique de Photographie: Dr. C. Fabre, Cinq$^e$ Fasc. B. (Paris, Gauthier-Villars).—Journal of the Royal Microscopical Society, December (Williams).—Century Magazine, January (Macmillan).—Quarterly Journal of Microscopical Science, December (Churchill).—Natural Science, January (Dent).

## CONTENTS.