THURSDAY, DECEMBER 20, 1894.

SIR RICHARD OWEN.

The Life of Richard Owen. By his grandson, the Rev. Richard Owen, M.A. With the scientific portions revised by C. Davies Sherborn. Also an Essay on Owen's Position in Anatomical Science, by the Right Hon. T. H. Huxley, F.R.S. (London: John Murray, 1894.)

THE life of this well-known and eminent anatomist, written by his grandson, the Rev. Richard Owen, has been based on such a large amount of material that "the writer's chief difficulty has been to compress the biography within reasonable limits." While acknowledging that the art of compression is a difficult one, we still must express some disappointment at the way in which it has been carried out in the two volumes of this biography. For over sixty years Owen filled a more or less conspicuous place in the scientific world; in a large measure a self-taught anatomist, he at a very early age became a teacher of anatomy to others, with a wondrous collection of material at his disposal to illustrate his teaching. In these volumes we do not seem to find enough about his evolution as a man of science, and we could, in some measure, have dispensed with many of the trifling details of his every-day life, which have, if any, but a passing interest. In the following sketch we attempt to show but a phase of Owen's character; but, in common with all who had any personal knowledge of him, we do not overlook, nor can we forget, the charm of his domestic and cultured life.

Richard Owen was the younger son of Richard Owen, of Fulmer Place, Bucks; he was born at Lancaster on July 20, 1804. His mother was of a Huguenot family of the name of Parrin, who came from Provence at the time of the revocation of the Edict of Nantes. He would seem to have inherited from his father many of his physical characters, his height and sturdy frame; while from his mother came his fondness for music, and a certain refinement and courtier-like style of manner which were of some value to him in after-life. Apparently his mental training began early, for we find his father writing from St. Kitt's to his mother, "that he was glad to know James (the elder brother) and Richard came on so well with their studies, and were so attentive," at a date when Richard could not have been more than three years and a half old. When six years old he was sent to the Lancaster Grammar School, to join his elder brother, a school that will be always associated with the name of Whewell, the great Master of Trinity, Cambridge, who received here his early education. Soon after he had left school, we find him apprenticed to Mr. Leonard Dickson, of Lancaster, surgeon and apothecary, and on his death, in 1822, he was transferred to Surgeon Seed, of the Royal Navy; and finally, on Mr. Seed being called upon by the Service, he was committed to the care of Mr. J. S. Harrison. Matriculating at Edinburgh University in October, 1824, he seems to have attended one winter, and possibly a summer, course of lectures. In 1825 he was in London, attending lectures at St. Bartholomew's Hospital School, and became prosector for Dr. Abernethy. On August 18, 1826, he was admitted a member of the Royal College of Surgeons, London.

To the medical student of the present day, compelled to attend a five years' course of lectures and demonstrations, and to pass several examinations, there will seem something enviable in the apparent ease with which Richard Owen obtained his qualification; there was an incomplete apprenticeship at Lancaster, perhaps a year's course of lectures at Edinburgh, and another year, about which we have few details, at St. Bartholomew's, and then he set up as a medical practitioner, and gradually secured a small practice among the lawyers at Lincoln's Inn Fields. To those, however, who try to read under the lines, it will be evident that the abilities and industry of Owen, about which his mother so proudly writes, must have been of no common order. Up in that old tower at Lancaster—"Hadrian's Tower, it was called"—after the first spasm of fright, the particulars of which are so graphically told us by the Professor himself, the youth of sixteen must have carried on his anatomical investigations to such a purpose that we find him, on his visit to Edinburgh, not only able to detect the defects of the teaching of anatomy of Prof. Monro (*tertius*), but able also to attract the notice of John Barclay, and finally, on his visit to London, able to act as prosector to Abernethy. We would have welcomed more information as to how Owen became an anatomist. Was his worthy master at Lancaster, who could learnedly descant on certain pathological conditions, an anatomist, or did the "elder fellow pupil" about whom he writes (who was he?) help him in his studies? Probably we will never know, and yet a knowledge of his doings during these few early years of study would have helped us to an understanding of the man.

In 1827, through the influence of Abernethy, who at the time was President of the College of Surgeons, Owen was appointed Assistant Curator of the College Museum, under William Clift, and he at once proceeded to arrange the collections and to write the descriptive catalogues, the first three parts of which were published in the course of 1830. Before the end of 1827 he was engaged to be married to Miss Clift, and after an eight years' courtship they were married in 1835. William Home Clift had died from an accident in September 1832, and Owen's place at the College then became a permanent one. In 1836 he was appointed Hunterian Professor, and on the retirement of Sir Charles Bell (in the early part of 1837) from the Professorship of Anatomy and Physiology in the College, Owen was elected to the vacant chair. For these latter statements we follow the text before us; but is it not possible that there is some slight confusion here? Up to about the period when Sir Charles Bell resigned the Professorship of Anatomy, the lectures bearing on the Hunterian collections were supposed to have been given in part by the Professor of Anatomy and in part by the Professor of Surgery; but, by a special arrangement, these lectures, twenty-four in number, were, after 1837, to be delivered by Owen, as Hunterian Professor, and "the awful first lecture" was given on May 2, 1837.

For the next twenty years of Owen's life the scene was for the most part laid in Lincoln's Inn Fields.

"'Mr. Owen' was put up on our door-plate to-day. Looks most imposing," records Mrs. Owen, under the date of July 22, 1836, and it was in June 1856 that he entered upon his duties as Superintendent of the Natural History Department of the British Museum. These twenty years were, perhaps, the fullest of Owen's life. The boy who had begun his anatomical studies in Lancaster at sixteen years of age, was, some sixteen years afterwards Hunterian Professor, lecturing before brilliant audiences of grown-up men, and with material to lecture about such as has seldom fallen to the lot of any other man. Numerous were the works published during these years, and numerous were the honours conferred on him. Fully detailed lists of both, occupying many pages, will be found at the close of volume ii. The time was not all spent in tiresome work; Owen's social qualities were of a well-developed order. We are permitted, by his wife's records of their daily lives, to know of days and evenings spent in gay and festive scenes.

In chapter ix. we have a fuller account than, we think, has to this been published about the daring thoughts that were at one time in Owen's mind (1846) about the zoological collections of the British Museum. He calls them "speculations on a concentration of all zoological illustrations—living, dead, exterior, and anatomical—in one great connected establishment"; but, failing such a realisation, he would be satisfied if "all the recent and fossil zoology of the British Museum would come to this (College of Surgeons). The mineralogy would naturally be transferred to the Government Museum of Economic Geology," and "the British Museum would then be left free for the full extension of the departments which concern intellectual man." The last sentence was unfortunately expressed; and within ten years, Owen's ideas—possibly affected by lapse of time and change of scene—had vastly changed. He thought, in 1846, Lincoln's Inn Fields as central a position as Great Russell Street; afterwards, in 1856, though he liked the position in Great Russell Street well, yet for the sake of space he went out into the country. Perhaps, in taking note of this episode, we ought also mention that in 1848 he strongly urged on his friend, Dean Buckland, the importance of the great collection of shells, made by Hugh Cuming, being purchased for the British Museum.

At the close of the first volume there is an interesting letter, dated July 17, 1854, from Charles Darwin, which we do not remember to have seen before. He thanks Owen for his kind appreciation of his work on the Cirripedia. "I got so frightened at the thoughts of all the seaside species, that I have not illustrated and given in detail nearly enough my anatomical work, which is the only part of the work which has really interested me. I find the mere systematic part infinitely tedious. I can, however, honestly state that all I have said on the males of Ibla and Scalpellum is the result of the most careful and repeated observation. If I am ever proved wrong in it I shall be surprised."

On May 26, 1856, Owen was appointed Superintendent of the Natural History Department of the British Museum, and he entered on his duties on June 8 following. We presume that he resigned his position at the College of Surgeons at the end of May, as the letter of the Secretary of the College, forwarding the regrets of the Council, is dated June 12, 1856. Lord Macaulay's letter to the Marquis of Lansdowne, urging that the post should be made for Owen, was written in February 1856; so that the one scene of labour was exchanged for the other almost with the rapidity of a transformation scene, and before the end of June, Owen was examining the "two collections of Mr. Hawkins—those of Dr. Mantell and Mr. Koch"—in the British Museum, which in 1846 he had believed to be so much out of place there. For the next twenty-seven years the interests of the wonderful collection were always very dear to him, and no difficulties, no rebuffs, stopped him from carrying out his plans about them to their uttermost.

Chapter ii. of vol. ii. is devoted to the history of Owen's connection with the British Museum of Natural History at South Kensington. This account "is given as nearly as possible in his own words, the substance being taken from his address to the British Association at York in 1881." It would have been well if this chapter had been revised by some one with a personal knowledge of the state of things existing in the Natural History Department of the British Museum prior to Owen's appointment, or, failing this, of some one up to the traditions of the place; for though, undeniably, space was sadly wanted for the proper display of the specimens, this department, as a department, was scarcely "the most neglected branch of the institution," nor could the condition of affairs be described as "chaos." However, in February 1859, Owen submitted his views in a report to the Trustees, asking for space to display the existing specimens and those that might be expected to come for a generation. Organised and crystallised forms, all were to be now included. This report, with plans, was presented to Parliament by the Trustees; the space demanded required the removal of the collections from Bloomsbury, the time had not come for so great a change, and Mr. Gregory, afterwards Sir William Gregory, here referred to as an "Irish Member," asked for a Committee of Inquiry, which, after a pretty vigorous debate on July 22, 1861, was granted. In May 1862 there was a second stormy debate in the House of Commons, led by Lord Beaconsfield, and the Government were refused leave, by a large majority, to bring in a Bill for the removal of portions of the Trustees' collections in the British Museum. Things, however, changed in 1863; Sir William Gregory had been made Governor of Ceylon (it is difficult to see what effect this could have had on the matter), and in June of that year leave was obtained by a majority of 132 to purchase five acres for the required Natural History building. Between 1880 and 1883 Owen was engaged in superintending the removal of the specimens from Bloomsbury to South Kensington, and at the close of the latter year he retired from his post, the realisation of his idea being attained.

When Owen gave up the charge of the Museum of the College of Surgeons, he also surrendered the Hunterian Chair; he was thus enabled to accept the Lecturership on Palæontology at the Royal School of Mines, in 1857. He gave his first lecture on February 26, concluding the course on April 2. Mrs. Owen notes in her diary, Richard's "design has been clear throughout in these lectures—to show the power of God in his creation." Towards the end of the same year he was appointed Fullerian Professor of Physiology at the Royal Institution, so that there was no relaxation in lecturing work during these years. Owen was President of the British Association at its meeting at Leeds in 1857. We also get a glimpse of him at Aberdeen in 1859, but can find no trace in these volumes of his presence at the Oxford or Cambridge meetings of 1860 and 1862; indeed, even when noticing the publication of the memoir on the Aye-Aye in 1863, no reference is made to the remarkable paper read at the Cambridge meeting on the characters of this mammal as a test of the Lamarckian and Darwinian hypotheses of the transmutation and origin of species, nor is there any allusion to the "two pitched battles about the origin of species at Oxford," nor to Charles Kingsley's well-meant little squib, published during the Cambridge meeting by Macmillan and Co., "On the great Hippocampus Question."

Mrs. Owen, after a married life of nearly forty years, died in May 1873. In 1875 Owen refers to his daily task work becoming tiresome, as well it might to a man past seventy, but several important memoirs were published by him between this year and 1885, and in 1881 he delivered a long address to the Biological Section of the British Association at York, on the new Natural History Museum; this was almost his last public address, and it was delivered with a force and power that reminded his hearers of his early days. On January 5, 1884, Owen was, on his retirement from the post of Superintendent of the British Museum, gazetted a K.C.B. He was present at a meeting of the Linnean Society, at Burlington House, in May 1888, "to receive a gold medal." The medal thus alluded to was one of two struck in commemoration of the centenary of the Linnean Society; one medal was to be given to a botanist, and one to a zoologist. The botanist on this occasion was Sir Joseph Dalton Hooker. Up to the close of 1889 he was occasionally seen at the Athenæum. Early in 1890 he had a slight paralytic seizure, from which he never entirely recovered. In his well-known library, when able to be out of bed, he would sometimes sit for hours looking out wistfully at the view over the park, and on the morning of December 16, 1892, the end quite peacefully came.

As to Owen's position as a writer on anatomical science, we have no occasion to enter, for what we conceive to be by far the most interesting portion of these two volumes is a criticism, in the true sense of this word, thereof so straightforward, searching, and honest as to leave nothing further to be desired. We should like to have transferred the greater part of this analysis by Prof. Huxley of the work done by Owen to our pages. He doubts "if in the long annals of anatomy more is to be placed to the credit of any single worker" than to Owen, and his is "work some of which occupies a unique position, if one considers, not merely its general high standard of excellence, but the way in which so many of the memoirs have opened up new regions of investigation."

As to the judgment passed on the speculative side of Owen's work, will not all now deplore that so much tireless industry, great capacity, and extensive learning were spent on themes profiting so little as the archetype of the vertebrate skeleton and the nature of limbs? Perhaps it may seem to some that Prof. Huxley has devoted too much space to Owen's speculative writings, but, as he says:

"Obvious as are the merits of Owen's anatomical and palæontological work to every expert, it is necessary to be an expert to discern them; and endless pages of analysis of his memoirs would not have made the general reader any wiser than he was at first. On the other hand, the nature of the broad problems of the 'Archetype' and of 'Parthenogenesis' may easily be stated in such a way as to be generally intelligible; while from Goethe to Zola, poets and novelists have made them interesting to the public. I have therefore permitted myself to dwell upon these topics at some length; but the reader must bear in mind that whatever view is taken of Sir Richard Owen's speculations on these subjects, his claims to a high place among those who have made great and permanently valuable contributions to knowledge remain unassailable."

Several interesting portraits of Owen, taken at different periods of his life, form part of the illustrations of these volumes. There are also sketches of the Gateway, Lancaster Castle, and of Sheen Lodge, in Richmond Park.

ELECTROMAGNETIC THEORY.

Electromagnetic Theory. By Oliver Heaviside, F.R.S. Vol. I. (London: The Electrician Printing and Publishing Company, Limited, 1893.)

THE basis of Mr. Heaviside's treatise is the interlinked magnetic and electric circuits. This is taken from Maxwell, but it is much more fully developed, and the analogy between the electric and magnetic circuits is followed out with great care, and is insisted upon at every turn. That you can have a conductor charged electrically, while you cannot have a single magnetic pole, destroys the perfection of the analogy but little. There is a more serious hiatus in the absence of the magnetic analogue to an electric conductor. Mr. Heaviside, however, completes the analogy by imagining such things as magnetic conductors and magnetic currents. The magnetic displacement and convection currents of course exist, but magnetic conduction current, with its corresponding magnetic conductivity, is a most useful notion. The ideas of the magnetic current must not be confused with the unscientific notions of magnetomotive force and magnetic resistance, which are supposed to bring electromagnetism within the intellectual reach of the benighted practical man. At first Mr. Heaviside uses the hypothetical magnetic current as a means of giving his readers a thorough grasp of the interlinked circuits, and of completing the analogy between them. Later, however, in dealing with submarine messages, he shows that magnetic conductivity outside the wires, which is easy to treat mathematically, would have the same effect on the messages as electric resistance in the cable itself, which would be more difficult.

As Mr. Heaviside's first volume has been already reviewed in the *Electrician* and *Philosophical Magazine* by Profs. Fitzgerald and Minchin, and as the work is so full and so suggestive that a review might be longer than the book, this notice will deal mainly with matters not already fully discussed, though of course there will be some overlapping.

It is almost needless to say that Mr. Heaviside does not believe in action at a distance, that he regards energy as being continuous in space, and as moving as matter, and that he treats ether as an entity, and not as a working hypothesis. By the way, in discussing ether, as to whether it is stationary or not, stationary is generally taken to mean relatively to the earth which is honoured with our existence, or at least with regard to the sun which is to give us light. But if motion is considered with reference to infinite distances, the chances are that the ether moves past us at a speed in comparison with which v is infinitesimal. Mr. Heaviside hopes that in the future the young will be trained up to believe in ether as a thing, and will therefore believe in it; but this would be a sort of religion rather than knowledge. No one doubts that electrical disturbances are propagated at a finite speed, and matter, with its inconvenient properties removed or altered, provides a convenient working hypothesis; but to talk of the inconceivable as existing, is using words to which no concepts belong. As most people agree with Mr. Heaviside on these matters, however, it may be as well to say no more in a review. Dealing with the medium, or rather its states, Mr. Heaviside gets rid of the potential treatment. To him induction and its change is of primary importance, and potential is a mere derivative of it. The idea of induction as the essential and potential as derived is less common with the academical than the practical electrician, who also uses the notion of lines of induction.

This treatise is remarkable, among other things, in beginning almost at once with the propagation of disturbances at the speed of light. The author hopes that text-books on light will soon discuss electricity at the beginning instead of at the end. He certainly sets a good example by beginning a book on electromagnetism with the propagation of disturbances in time. By the way, he regards chemistry as an unmathematical science; it is to be hoped chemistry books will soon begin with thermodynamics and electricity, so as to lay an engineering foundation for the study of chemical action.

Mr. Heaviside is, as is well known, a determined opponent of the use of quaternions in physics, and an equally strong advocate of the use of vectors; and a long chapter is devoted to the "Elements of Vectorial Analysis," taking more than a third of the book. In quaternions, vector products have a part at right angles to both the vectors; the ideas thus fitted electromagnetism, and Maxwell availed himself of the conveniences of quaternion notation, and, to some extent, of quaternion ideas. The relations between vectors in quaternions are purely conventional, while in electricity they are physical in one sense, though in another they may be due to conventionalities of definition. The idea of the direction of a current flowing along in a wire was derived from the flow of water in a pipe, and it is possible that we might have so defined electrical and magnetic quantities, and so thought of them, that nothing corresponding to vector products or quotients came in when passing from one to the other of the electric and magnetic systems. Mr. Heaviside objects altogether to quaternions in physics, but does not differentiate clearly between vector and quaternion analysis, and professes that he does not or cannot understand quaternions. It is not likely he cannot. Perhaps he won't. One difficulty, in the way of students at least, is due to writers on quaternions defining something that is not adding as addition, and something that is not multiplying as multiplication, and to their removing the operand and treating the operator as a quantity. This leads to $S\alpha\beta$ being negative, to the square of a vector being negative, and to the reciprocal of a vector being taken in the opposite direction. When an eminent scientific writer recently found, by dividing the value of dy/dx by y that d/dx was equal to 628, some wrongly thought he did not understand the principles of the calculus; but he was only doing in figures what is done in letters in many branches of mathematics. Mr. Heaviside starts off with a definition of the "product" of two vectors. The scalar part is positive, and the vector part is as in quaternions, but there is no idea of the multiplier rotating the multiplicand, though he gives no reason why the multiplicand need not be looked upon as turned through a right angle. It may be asked how Mr. Heaviside avoids quaternions. Using the word in one of its many senses as the operator necessary to change a vector into another, he avoids the difficulty, for the present, by not dividing. Surely if vectors are to be multiplied they must also be divided. If we have the induction and current at an angle, we can find the force; is it not as reasonable to find the induction or current if the force and one of them is given? Perhaps Mr. Heaviside may devise a new quotient or operator which will do this. If $\alpha\beta = \gamma$ we might expect that $\gamma/\beta = \alpha$. This is not so in quaternions, because the scalar part of $\alpha\beta$ is lost, and the quaternion γ/β gives no scalar part. To recover α there might be a term $S\alpha\beta/\beta$. Perhaps Mr. Heaviside will give his own ideas about division in his next volume. Meanwhile, though he avoids the ideas of turning, every vector multiplier is just as much a quaternion as any in Hamilton or Tait, as far as the versor is concerned. A quaternion, though sometimes called an operator, is really two operators. Mr. Heaviside admits quaternions can be developed from his definitions. He also finds it difficult to think of energy disappearing in one place and appearing elsewhere without passing through intermediate space; surely then he can look upon a vector disappearing and reappearing in a new direction, and of a new length, as having passed through intermediate positions and lengths. He then gets the idea of roots of quaternions, $\sqrt{-1}$, and so on, without complicating vector analysis, and has a system which will do all his vector algebra well, which makes sense of imaginaries and exponential values of sines and cosines, which does not involve the study of new symbols or ideas, and which is already worked out: in short, quaternions. He finds difficulty in knowing when a vector is a vector, and when a quaternion. The answer is: it is a vector when it is a quantity, and the versor of a quaternion when it is an operator. There would be no difficulty if people did not confuse an operator with the quantity that specifies it. Confusion, which is common to Mr. Heaviside's vector algebra, may come in between the scalar and vector part of the product of two vectors. He continually falls back on cartesians, and his vector work is apt to degenerate into cartesian shorthand. The object of a calculus is not to save printing, and it is no advantage to have an expression condensed into two or three symbols if you have to think it out at length to understand it. Shorthand is not necessarily short-thought, especially if it also involves writing operators as quantities. It is possible to know the meaning of

$$\left(\mu p - \frac{\nabla^2}{cp}\right) \text{H where } \frac{1}{p} \text{ is } \frac{dt}{d},$$

it is also possible to know what is meant by "Boyle was the father of chemistry, and brother to the Earl of Cork." It might be suggested that if Mr. Heaviside wants to make either vector analysis or quaternions simple to physicists, he should avoid the confusion between operators and quantities, and between operation generally and multiplication in particular; or else write an introductory calculus of functions showing where such liberties can be taken with impunity.

Mr. Heaviside has a rooted aversion to 4π. This factor came into the system of units from statics, as the mathematical treatment of electricity was much the same. Mr. Heaviside employs a medium treatment, and thinks that 4π should, therefore, disappear. He thinks that Maxwell and other mathematicians did not know how 4π came about, and thought it was a physical necessity. With his treatment it is an advantage to remove the 4π from its usual place; but it only appears in the denominator elsewhere. It is like the eruption due to a disease: suppress it, and it appears elsewhere. The unsavoury metaphor is not ours. The disease is the area of a unit sphere being 4π. Until Mr. Heaviside can cure that, he cannot really eliminate 4π. He whitewashes 4π whenever it appears in his book, saying that it is not the B.A. 4π of amazing irrationality. When a man refers to his own ideas as alone rational, or based on common-sense, or well-known facts, he is generally wrong.

Mr. Heaviside is, as is well known, a prolific inventor of new terms. He says he hates grammar; he has also a murderous hatred of the Queen's English when inventing terms such as "leakance," "reactance," and "potted." Generally speaking, a writer has no business to insist that his reader shall study a new terminology; but when any one of Mr. Heaviside's reputation invents names which are euphonious and good, they become parts of our language, and we must thank him, especially when his terms are suggestive and systematic. The example is bad though. The English language is capable of improvement; but if every writer is to alter it to suit his ideas, it will not improve. It is a matter of taste which terms should be adopted; many object to voltage and gaussage as unsystematic where ampereage, farradage, &c., are not used. Voltage was originally used to denote the pressure for which lamps, dynamos, &c., were designed by the maker, whatever they were run at. Pressure belongs to the same set of ideas as current, capacity, resistance, and quantity; and if they are used, should also be employed. It is, however, a matter of taste only.

The style is that of Whitman, except that Mr. Heaviside is not affected, and has something to say. The similarity is also noted in the *Philosophical Magazine*. Every line of the book is important, and it is full of interesting digressions on all sorts of subjects. Though the converse may not be true, all clever men have a sense of humour, and it is therefore a pity that scientific writers emulate the ponderous dryness of the theologian. Mr. Heaviside's work bristles with humour of a type which he has invented.

It is generally assumed that a review should be written by a man who could have written the book himself. In the case of a writer of Mr. Heaviside's calibre there is difficulty in getting such reviewers. The real object of a book is, however, to teach not those who know the contents already, but the student, and it may therefore be an advantage to review a book from the student's point of view. This review must, therefore, be taken as from that point of view; that is, as written by a reader who has not devoted a large enough portion of his time to the study of mathematics or mathematical physics to be more than a student of them.

J. SWINBURNE.

RECENT PSYCHOLOGY.

Lectures on Human and Animal Psychology. By Wilhelm Wundt. Translated by J. E. Creighton and E. B. Titchener. Pp. x. 454. (London: Swan Sonnenschein and Co., 1894.)

Grundriss der Psychologie. Von Oswald Külpe. Pp. viii. 478. (Leipzig: W. Engelmann, 1893.)

Introduction to Comparative Psychology. By C. Lloyd Morgan. Pp. xiv. 382. (London: Walter Scott, 1894.)

Psychology for Teachers. By C. Lloyd Morgan. Pp. x. 251. (London: Edward Arnold, 1894.)

Primer of Psychology. By George Trumbull Ladd. Pp. xv. 224. (London: Longmans, Green, and Co., 1894.)

THE translation of Prof. Wundt's well-known lectures is taken from the second revised German edition which appeared in 1892, and is therefore well up to date. It is the first work of the author to appear in English, and the choice made by the translators is a good one; while the book will give to those specially interested in psychology a general sketch of the author's views. Its popular and lucid form will appeal to a wider circle of readers who would hardly care to digest the details and technicalities of the "Grundzüge der physiologischen Psychologie."

The greater part of the book is devoted to human Psychology, especially in its physiological and experimental aspects, and there are several interesting chapters on animal psychology, and a short account of the author's views on hypnotic conditions. Prof. Wundt's own opinions are stated rather more dogmatically than is altogether suitable for an elementary book in a science like psychology; thus, in dealing with intensity of sensation, the validity of the logarithmic formula is very positively enunciated, and it is somewhat surprising to find on p. 306, that indirect association of ideas is "easily demonstrated," when several investigators, one recently in Prof. Wundt's own laboratory, have failed to find any evidence of such a mode of association.

The translation has been very well done, and especial care has evidently been devoted to the rendering of the German psychological terms. The translators have very freely used the term "to sense" as a verb corresponding to sensation, and as the equivalent of "empfinden." This American innovation, which has already been advocated by Dr. Titchener, is also used by Prof. Lloyd Morgan in his two books, and it must be acknowledged that there is decided need of some such term.

Dr. Külpe is chief assistant to Prof. Wundt at the Leipzig Institute, and his experience in teaching and in directing investigation must have contributed largely to make his book what it is—one of the best existing expositions of experimental psychology. The general teaching follows that of Wundt, but there is much that is novel in matter and arrangement. Physiological details and the technique of experimental methods are omitted or treated very briefly, but the principles of the methods are fully discussed. Dr. Külpe's book will probably be largely used as a text-book for advanced students.

Prof. Lloyd Morgan's two books, to a certain extent, cover the same ground. Each is an exposition of general psychological principles to serve as guides, in the one case, to the scientific study of the animal mind; in the other, to the practical study of the child's mind. Both books are characterised by the sound common sense with which the author treats his problems.

The views held on the nature of the animal mind are very similar to those of Wundt. Both agree that in studying animal psychology the scientific method is to explain actions by the simplest possible mental processes, and this method has led both to similar conclusions, although expressed in somewhat different language. Wundt refers all intelligent acts of animals to simple associations, to the exclusion of any higher apperceptive process; while Prof. Morgan explains such acts by simple sense experience, and doubts, though he does not deny, the existence of any true reasoning or reflective process. A point justly insisted on by Prof. Morgan is that observation of an apparently rational action in an animal is of little value without knowledge of the process by which the action has been developed; "in zoological psychology we have got beyond the anecdotal stage; we have reached the stage of experimental investigation."

The book for teachers is very interesting, and contains much that should be of practical value. It is noteworthy that the appreciative preface, with its ample recognition of the part that a knowledge of psychology should take in the equipment of the teacher, is written by Dr. Fitch, late one of H.M. Chief Inspectors of Training Colleges.

Prof. Ladd has attempted a very difficult task in writing a primer of psychology suited for the young. His book is often simple and clear; it is to be feared, however, that youthful readers will find much of it beyond their capacity. The author has, at any rate, avoided the fault of being too dogmatic.

OUR BOOK SHELF.

Radiant Suns. By Agnes Giberne. (London: Seeley and Co., 1895.)

IN this sequel to a former work, the reader is taken by easy stages into the domain of spectroscopic astronomy and the evolution of worlds. Though following some astronomers who ought to know better, the authoress takes the unphilosophical view that the whole process of stellar evolution is one of cooling; and this is the more difficult to understand, as she is evidently not unfamiliar with the fact that a condensing body may actually be getting hotter (p. 307). While strongly advocating the value of hypotheses as aids to investigation, she is inconsistent enough to make contemptuous reference to the "half-fledged" theories of "scientists of a lower order" (p. 240); her qualifications for making such distinctions are not very clear to us, but her opinions seem to depend to some extent on personal bias, since special prominence is given to the views and work of one observer.

A preface is contributed by Mrs. Huggins, who is careful to disclaim responsibility in matters of opinion, and laments that the masses of men overlook the fact that "the investigator, absorbed in pursuits far removed from those of ordinary life, is also a toiling worker, and a worker of the highest order."

The illustrations are admirable and quite up to date. It would be worth while, however, to revise the coloured plate of stellar spectra, so that the spectrum of Vega would not be robbed of its strongest characteristic—the lines of hydrogen.

We believe that the book will succeed in awakening a desire for further knowledge in the minds of thoughtful readers; and if so, it will serve a useful purpose.

Album von Papúa-Typen. Von A. B. Meyer and R. Parkinson. (Dresden: Stengel und Markert, 1894.)

TO ethnologists, the Papuan race is one of the most interesting in the world. Whether the Papuan represents a distinct type of mankind or not is doubted by some observers, though the balance of evidence is in favour of that conclusion. This splendid collection of fifty-four plates reproduced from photographs, and representing about six hundred portraits of individuals, should be of great assistance in studying the similarities and differences between the typical Papuan, and the natives of southern and eastern New Guinea. The photographs illustrate the natives of New Britain, the Duke of York Islands, New Ireland, Admiralty Islands, Solomon Islands, German New Guinea, and Dutch New Guinea. They represent the people as they are ordinarily seen, and also decorated with the strange costumes assumed at feasts. Particularly striking are the pictures of natives of New Britain adorned for one of their Dukduk dances, and of the ingenious basket-work traps used by the fishermen. Ethnology will benefit by the publication of this collection of really excellent pictures.

Farm Vermin, Helpful and Harmful. By various Writers. Edited by John Watson, F.L.S. Pp. 85. (London: William Rider and Son, Limited, 1894.)

COMPOSITE books are almost always unsatisfactory, the chapters by the various contributors being necessarily unequal in quality and length. We really cannot understand why this little book of eighty pages should not have been written by a single zoologist, instead of the eight who have helped to construct it. The only justification for the patch-work is that each of the writers is more or less an authority upon the subject he describes; but the book is of such an elementary character, that it is difficult to believe that so many minds are necessary for its construction. The contributors are Sir Herbert Maxwell, Mr. O. V. Alpin, Mr. John Cordeaux, Mr. Cecil Warburton, Dr. J. Nisbet, and Mr. C. B. Whitehead. Each tells his tale in his own way, and the editor amplifies the information here and there by means of foot-notes. Farmers will find the book a handy and simple guide, and one which will enable them to know their friends and enemies among the "varmints."

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 New Cypress of Nyasaland.

THE interesting account of *Widdringtonia whytei* (NATURE, November 22, pp. 85–87) discovered by Mr. Whyte on the Milanji plateau, suggests a few brief comments.

(1) It is said to extend "the geographical range of the genus hitherto known only from South Africa, Madagascar, and Mauritius into tropical Africa." As far as the latter statement is concerned, this is no doubt true. But the existence of any species of the genus in Madagascar or Mauritius seems to be wanting in sufficient evidence, though repeatedly cited by authorities. Thus Madagascar is given in the geographical distribution for the aggregate genus *Callitris* in Bentham and Hooker, "*Genera Plantarum*," vol. iii. p. 424; Dr. Masters, *Journ. Linn Soc. Bot* vol. xxx. p. 17, says "one (*Widdringtonia*) has been discovered in Madagascar"; Mr. Rendle, *Trans. Linn. Soc.* (2nd series) *Bot.* vol. iv. p. 61, speaks of the "South African and Mascarene *Widdringtonia.*"

All these statements are based on a species, *Widdringtonia Commersonii*, which was *cultivated* at Réduit, Mauritius, and of which the native country was assumed to be Madagascar, though this has never been confirmed.

In 1806, it is referred to in the "Nouveau Duhamel," vol. iii. p. 10, as *Thuya quadrangularis*, with the following remark: "Habite l'isle de Madagascar; depuis quelques années ou le cultive au réduit, jardin de botanique a l'Isle de France."

The Madagascar habitat was apparently purely conjectural. And though the island has of late years been pretty assiduously worked by French, German, and English botanical collectors, no conifer has been detected in it except *Podocarpus*.

In 1833 the development of the myth went a step further. Brongniart cites the species in the *Ann. des Sc. Nat.*, series 1, vol. xxx. p. 190, under the name of *Pachylepis Commersonii*, with the remark: "Hab. in Insula Mauritii in loco dicto Le Réduit (Commerson, 1769)."

Thus it will be seen that, starting as an introduced Madagascar species cultivated in a botanic garden in Mauritius, it finishes with being treated as an undoubted native of that island.

It is, however, to be noted that from "Baker's Flora of Mauritius and the Seychelles" (1877) the *Coniferæ* appear to be entirely absent from the Mascarene Islands.

(2) There is nothing improbable in a *Widdringtonia* occurring in Madagascar. But none has yet been detected with any certainty. It seems not improbable that Commerson's plant was really derived from South Africa. This would seem to be the conclusion at which Carrière arrived in 1867, "Conifères," ed. ii. p. 67:—"Cette prétendue espèce me parait être à peine une forme de la précédente." (*W. cupressoides*, one of the two South African species).

(3) The *Coniferæ* for the most part can hardly be regarded as other than a very ancient and a decaying group. Their existing distribution is therefore peculiarly interesting. Bentham and Hooker unite under *Callitris* a number of small genera which practically only differ in the number of their ovule-bearing scales and in their geographical distribution. They divide the genus so reconstituted into four sections, of which two are broadly Australian, two are African. Other instances of parallelism between the Australian and African floras are well known and are full of interest. Of the African sections one is confined to the north, with one species, *Callitris quadrivalvis*, which yields the gum Sandarach of modern commerce, and produced the Thyine wood once so prized by the Romans; the other section, with two species, is confined to the south. The occurrence of a third species on the Milanji highlands is entirely in harmony with what we know of the distribution of plants in Tropical Africa. As has been shown now in numerous cases, a temperate and possibly more ancient flora more or less overlies at elevations where it can exist, the lower lying tropical one, and it forms a series of broken links by which the connection of the temperate flora of Europe and of the Mediterranean basin with that of South Africa, and even of the Madagascar uplands, are at least indicated.

It may be remarked that another coniferous genus, *Podocarpus*, behaves much in the same same way as *Callitris*. Four of the five African species occur at the Cape, and two on Kilima-n'jaro. *Juniperus*, on the other hand, though well represented in Northern Africa, occurs in Abyssinia and the Masai country, but yet does not reach South Africa.

W. T. THISELTON-DYER.

Royal Gardens, Kew, December 10.

The Kinetic Theory of Gases.

I SHOULD like to ask Mr. Culverwell what are the "other considerations" from which we know that in a system of elastic spheres the error law gives the only permanent state.

I will endeavour to extend the proof of the H-theorem which I gave for elastic spheres to a more general, but not the most general, case.

The coordinates of a molecule are x, y, z, defining its position in space, and $q_1 \ldots q_{n-3}$, the momenta are $p_1 \ldots p_n$; and different values of the same variables shall be denoted by PQ and, as the case may require, by accented letters p'P', &c. The number per unit volume of molecules, for which the variables p and q are between assigned limits, is $f\,dq\,dp$, and f is a function of the p's and q's independent of $x\,y\,z$.

The number of pairs for which one molecule has variables P'Q' between assigned limits, *i.e.* is in the state P'Q', and the other $p'q'$ between assigned limits, *i.e.* is in the state $p'q'$, is $F'f'aP'dQ'dp'dq'$.

Each molecule has a centre of gravity. It is possible to describe a sphere about that point as centre, such that if the centre of gravity of another molecule be on or beyond that sphere, no appreciable force is exerted between the two molecules. Let a be the least radius of such a sphere. Then when the centre of one molecule is on the sphere of radius a described round the centre of another, an encounter begins or ends between the two molecules.

Now suppose an encounter to take place between a pair of molecules one of which is in the state P'Q', and the other in the state $p'q'$. As the result of the encounter the variables $P' \ldots q'$ assume new values, but what particular values they shall assume, given $P'Q'p'q'$ before encounter, depends on the two coordinates $\theta'\phi'$ defining the position of the centre of one of the two molecules on the "a" sphere described about the centre of the other at the commencement of the encounter.

Inasmuch as no work is done in moving the centre of one molecule on the surface of this sphere, it is evident that the "sorting demons" can make the result of the encounter anything that they please, *conservatis conservandis.*

Let us suppose that if these spherical coordinates lie between the limits θ' and $\theta' + d\theta'$, ϕ' and $\phi' + d\phi'$, the variables will after encounter lie between the limits $P \ldots P + dP$, &c., that is, the pair will be in the state Pq, and $\theta'\phi'$ will have become $\theta \ldots \theta + d\theta$ and $\phi \ldots \phi + d\phi$.

I will now assume (condition A) that the coordinates $\theta'\phi'$ are taken at haphazard without regard to the variables $P'q'$; if that be so, the chance that, for given $P'q'$ before encounter, the pair of molecules shall be in the $Pq\theta\phi$ state after encounter is $\frac{d\theta' d\phi'}{4\pi}$.

But the number of pairs which now are in the state $P'q'$ is

$$F'f'dP' \ldots dq'$$

And therefore the number which after encounter will be in the state $Pq\theta\phi$, having passed thereto from the state $P'q'$, will be

$$F'f'dP'dQ'dp'dq'\frac{d\theta' d\phi'}{4\pi},$$

which is equal to

$$\frac{1}{4\pi}dPdQdpdqd\theta d\phi \,.\, F'f'.$$

Now let P′ . . . q′ be made to pass through all values from which, θ′ and φ′ being suitably chosen, they can assume after encounter the given values P . . . P + dP . . . q . . . q + dq. The final values of θ and φ will vary, but all possible values of θ and φ must appear for some or other of the values through which P′ . . . q′ pass, and therefore we shall by this process obtain the whole number of pairs which are in the state P . . . q after encounter, without restriction of the state which they had before encounter. It will be, namely:

$$dPdQdpdq \cdot \frac{\iint F'f'dP'dQ'dp'dq'}{\iint dP'dQ'dp'dq'}$$

But the number which are in the state P . . . q now is

$$dPdQdpdqFf.$$

Therefore, as the result of encounters, it is increased by an amount proportional to

$$dPdQdpdq\int\int(F'f'-Ff)dP'dQ'dp'dq'.$$

From this point, thanks to the labours of Boltzmann and Watson, the proof is easy, and I need not repeat it, that $\frac{dH}{dt}$ is negative or zero.

I have assumed condition A. I do not say that that is the only assumption that will answer the purpose. But it is sufficient. And it is, I think, the most useful assumption, because the distribution of coordinates assumed to exist is that which would tend to be produced by any disturbances acting on the system from without.

The proof in this form is not open to the objection that by reversing the velocities we can prove two mutually contradictory propositions.

Oh, that now my friend would write a book, and point out with regard to these assumptions what more is necessary, or what less sufficient. S. H. BURBURY.

Lincoln's Inn, December 5.

P.S.—Dr. Larmor describes the reverse motions as the "exceptions which do not disprove the rule." I would apply the maxim *Exceptio probat regulam* in a slightly different sense. They are the exceptions which put the rule to the proof. They compel you to define accurately the limits within which the rule holds. When that has been done for Boltzmann's law (if it has not been done already), it will be time to consider how far the cases which fall within the law are more important than those which fall without it. S. H. B.

December 15.

THE presence of any assumption in Dr. Watson's able proof of Boltzmann's Minimum Theorem might easily be overlooked; but if Mr. Culverwell will apply his test of reversing the motions in each separate stage of the proof, he will unearth the assumption at once. On the top of p. 43 Dr. Watson says:

"And therefore the expression

$$FfdP_1 \ldots dq_{n-1}\, q_n$$

is the number of pairs of molecules, one from each of these sets, passing from the state P, P + dP . . . q, q + dq to the state P′, P′ + dP′ . . . q′, q′ + dq′ per unit of time, where q_n is put equal to 0 in f."

Now let the motion of every molecule be reversed as Mr. Culverwell suggests. It will be convenient to speak of the two states as the *unaccented* and *accented* states, and we shall thus have the assumption that the expression

$$FfdP_1 \ldots dq_{n-1}\, q_n$$

(which is also equal to

$FfdP_1' \ldots dq'_{n-1}\, q'_n$ but *not* to $F'f'dP_1' \ldots dq'_{n-1}\, q_n'$)

shall represent the number of pairs of molecules passing back *from the accented to the unaccented state*, and this number will depend on F and *f*, *the frequencies of distribution which the molecules are about to have after the collisions have taken place.*

If this assumption be made we doubtless shall have a case in which H tends to a maximum instead of a minimum, and if Mr. Culverwell endows his molecules with the power of forethought and the prediction regarding their future state necessary to enable them to regulate their movements according to this suppositious law, then Dr. Watson's proof, and indeed any proof, will necessarily fall to the ground. If however the motions of the molecules are allowed to take their own natural course, and nothing special is known about them, the only reasonable assumption to make is that the number of pairs passing from the accented to the unaccented state per unit time is

$$F'f'dP_1' \ldots dq'_{n-1}\, q'_n$$

and this assumption is actually made by Dr. Watson in the next few lines of his proof that H tends to a minimum.

What Mr. Culverwell's objection shows, then, is that it is possible to conceive the molecules of a gas so projected that they would not tend to assume the Boltzmann-Maxwell distribution.

But practically it would be impossible to project the molecules in their reversed motions with sufficient accuracy to enable them to retrace their steps for more than a very few collisions, just as, if we try placing a number of pool balls in a straight line on a billiard table at distances of a foot or two apart, we find it impossible to project the first ball with sufficient accuracy for each ball to strike the next in front all down the line if there are many balls.

The question of the choice of coordinates has been so fully dealt with by Dr. Watson that I need say nothing more. However, if Mr. Culverwell prefers, he may transform from Dr. Watson's $Q_1 \ldots q_n$ to any other variables defining the position of the *pair* of molecules, *provided that he works with the corresponding generalised momenta* instead of $P_1 \ldots p_n$, and he will have no difficulty in choosing one of his *new* variables to be such that it vanishes at an encounter.

I think Lorentz's paper ("Sitzungsberichte der Wiener Akademie," 1887, p. 115) affords the fullest account of the assumptions underlying the proof of the Minimum Theorem.

Cambridge, December 5. G. H. BRYAN.

Science and History.

I SEE by your review of the *National* in the last number of NATURE, p. 162, that Prof. G. W. Prothero, in his "Address on History," takes occasion to notice Buckle's "History of Civilisation." "Buckle," he says, "in illustrating his theory that national character depends largely upon food, attributes the weakness of the Hindoos to an almost exclusive diet of rice. A striking but misleading generalisation, for, as Sir H. Maine has pointed out, the great majority of Hindoos never eat rice at all." Buckle, however, never said anything of the kind; and since no author wrote more clearly than he did, it is evident that the Professor, like many before him, has not taken this extract at first hand.

What Buckle did say was: that rice, millet, or whatever the Hindoos fed on, was grown with little trouble and in abundance; that the climate made clothes superfluous; that living was consequently cheap, and that hence the population increased beyond the demand for labour; labour was ill-rewarded, and the population became practically enslaved. I put the argument very shortly and inadequately, for any one may see it fully set forth in the "History of Civilisation," 1858, vol. i. pp. 63-74.

Sir H. Maine utterly failed to perceive that whatever might have been the food that the Hindoos lived upon, it made no difference to the argument provided that that food was cheap. He was further wrong in his statement that the Hindoos did not feed on rice, as it used to be a far more usual article of diet than in later times; but his worst mistake was to limit the argument to the people of India, who were only one people, out of many, used to illustrate the point.

ALFRED H. HUTH.

London, December 18.

Geometry in Schools.

As a mathematical teacher of long experience, I wish to state that I thoroughly agree with Prof. Henrici that experimental geometry should be taught *antecedently to* and *concurrently with* a rigorous deductive course.

Teachers who have to introduce young students to the study of deductive geometry (*to begin Euclid*, as it is called) are confronted with two difficulties. Their pupils in many cases (1) have never been seriously taught to reason about anything; (2) have no stock of geometrical ideas to reason about. The attempts made in kindergartens to give sound notions of form by means of models, patterns, &c., are excellent as far as they go, but there seems to be great need of a systematic course specially designed to lead gradually up to the study of deductive geometry. The following books will be found useful by teachers who care to give the experimental method a trial: "Paper Folding," by T. Sundara Row (Addison and Co., Madras); "Inventional Geometry," by W. G. Spencer (Williams and Norgate); "Experimental Geometry," by Paul Bert (Cassell and Co.); "Natural Geometry," by A. Mault (Macmillan and Co.); "Geometrical Drawing," by A. J. Pressland (Rivington, Percival, and Co.). To these may be added some older ones, which may occasionally be picked up second-hand: Scott Russell's "Geometry in Modern Life," Dupin's "Mathematics," and "Conversations on Geometry" (Anon.).

Adelaide Square, Bedford. EDWARD M. LANGLEY.

LILIENTHAL'S EXPERIMENTS IN FLYING.

IN a previous article in NATURE (vol. xlix. p. 157) we had occasion to refer to the very interesting experiments which were being carried out by Herr Otto Lilienthal with regard to the possibility of human beings being able to acquire the art of flying through the air, more or less, in the fashion of birds.

These investigations in aerial navigation are conspicuous from all other attempts of the present day, by their great difference in the method of procedure adopted. The principle of Maxim's machine, for instance, is to construct an apparatus to navigate the air by itself, carrying one or more passengers. Every movement of the machine, however, is left to the apparatus itself, and to battle with the difficulty of sustaining its own equilibrium the mechanism must necessarily be most complicated.

Lilienthal depends for the success of his apparatus on himself, trusting to his powers of *instinct* to keep his equilibrium by corresponding movements of his centre of gravity. Man in this case is the main flyer, the apparatus being only an adjunct, and it is from the ability of the former that he expects to obtain positive results. His apparatus is simple, cheap, and easily constructed; these are great points, as experiments can be carried on, even at the expense of the loss of a few machines.

The whole success of aerial flying can be summed up in the word *equilibrium*, and it is here that the difficulty lies. Given a perfectly quiet or very nearly still air, there is no doubt that machines can be constructed so as to soar and travel through the air. This state of atmosphere is very rare; but, on the other hand, there are all sorts of disturbances, currents, and wave-motions which render aerial navigation a far greater difficulty than is usually imagined.

One often envies a bird which, with perfect ease, soars above us; but it must be recollected that it is endowed with a delicate system of nerves which are always on the alert, and answer to any call made on them to sustain equilibrium. These movements are made quite unconsciously, and with the loss of the minimum amount of energy. To construct an apparatus that would accomplish this in an efficient manner would be simply impossible; but there seems no reason why man should not approximate to it to a certain extent by the help of an appropriate framework. With perseverance and many trials he should be able to master at least some of the rudiments, and eventually make short flights.

For this reason Herr Lilienthal's experiments must be looked upon as yet only as first attempts, and consequently as experiments pure and simple, and experience only will show how far they can be successfully brought. Falls must be expected in the preliminary trials until the operator becomes accustomed to the many new conditions which make themselves apparent at every step, before they can be mastered instinctively. Similar difficulties have to be contended with when learning to ride a bicycle. The beginner is at first unable to keep his equilibrium, and so wobbles here and there, with the loss of much power, until he eventually finds himself hugging the earth. This is simply because he is doing something unusual, and is not accustomed to the new conditions. An adept rider, on the other hand, never thinks of the possibility of falling, and quite unconsciously keeps his equilibrium without any exertion or

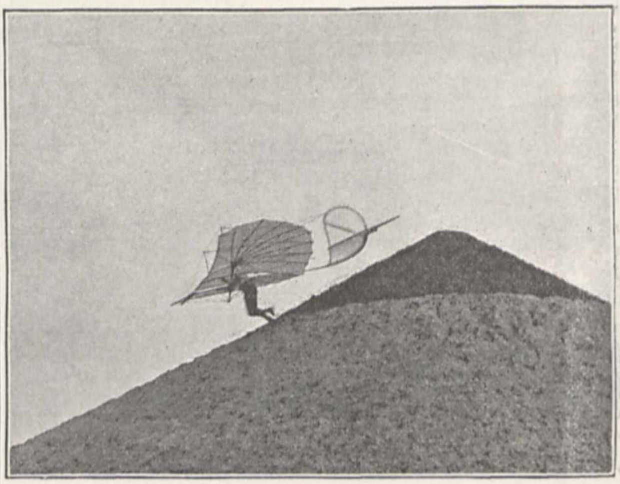

FIG. 1.

loss of power on his part. So it is with this new sailing machine, and it is only by practice that success can be attained.

To commence operations the simplest apparatus must be used, and the easiest steps attempted. This is the way Herr Lilienthal began. In his first experiments, with the help of his wing-shaped framework, he made flights from elevated points in calm weather, the lengths

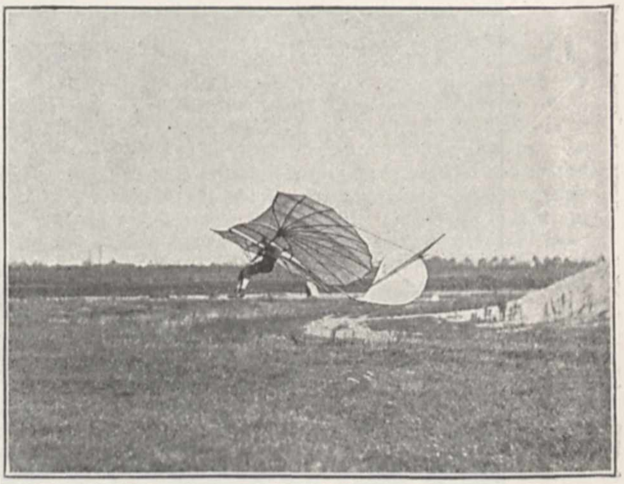

FIG. 2.

of these flights increasing as he gained in experience. Sometimes as many as 500 metres were covered in one bound under satisfactory conditions.

In his more recent experiments he has been making considerable progress in developing this mode of sailing. Two objects have been kept well in mind: the first, to accomplish that method of sailing which is adopted by birds which spend hours in the air at a time without ever flapping their wings; and second, to apply to his apparatus such dynamical means that will enable him, when sailing in a calm atmosphere, to prolong his flights.

To carry out these experiments he has thrown up, in the neighbourhood of Berlin, a large conical mound, fifteen metres in height; this mound he uses as a starting-point for his flights. In Fig. 1 the operator is shown just commencing one of these flights.

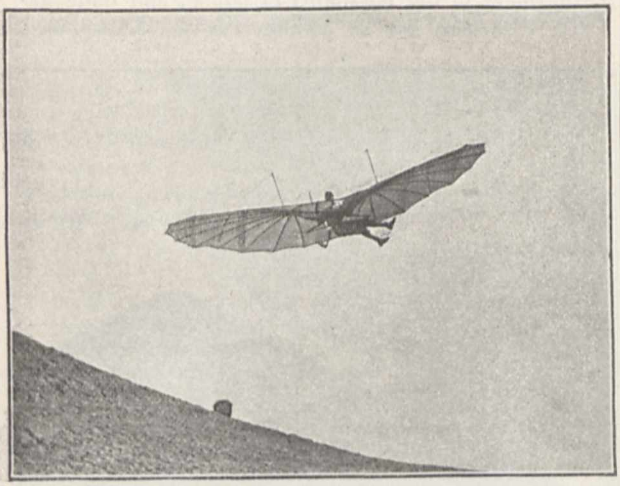

FIG. 3.

With a tight grip of the framework with his hands, he runs quickly down the slope until he has attained a sufficient velocity to raise him and his apparatus off the ground. When such conditions have been obtained, he sails off until he alights again on the earth. Fig. 2 shows him just about to alight. It will be noticed that to come down easily and softly, he puts on the brake by offering to the air a greater expanse of wing, whereby his velocity is at once reduced.

By experience Herr Lilienthal has found that although in quiet weather he can manipulate his craft very easily, in windy weather the operator has to be more careful. The investigations in this direction have, however, been satisfactorily made, and he can now by an adroit movement of his body and that of the apparatus sustain his equilibrium, and sail successfully.

In his article on this subject (*Prometheus*, No. 261, p. 7), from which these references to his new experiments have been taken, he states that sometimes, when a strong wind was blowing, he has been surprised by sudden gusts, which, before he had time to make the necessary movements to sustain his equilibrium, had carried him high up in such a manner as to often take his breath away.

Fig. 3 illustrates the operator receiving such a sudden shock; it will be seen at once that to contend with these new conditions he has had to bring his sail up to the direction of the blast, and to meet it if possible, while at the same time he has altered his whole centre of gravity by a movement of the lower part of his body.

Such movements as these cannot yet be made quite instantaneously, owing to lack of experience; but, as he justly remarks, with more practice he will no doubt be able to make them instinctively, just as the bicycle-rider does.

To attain his second object, that is, to employ some mechanical aid to help him to sustain himself for longer intervals of time in the air, he has constructed a new apparatus, somewhat, but not quite, similar to that up till now used. A good idea of this can be obtained from the accompanying illustration (Fig. 4).

FIG. 4.

A comparison of this *flying* machine with the *sailing* machine in the previous figures will show that the extremities of the wings have been differently constructed, being composed at the ends of a series of feather-like sails. These latter are connected with a small machine, near the operator's body, which is driven by compressed carbonic acid gas; it is set in motion by a simple pressure of the finger. Such an addition has of course increased very considerably the weight and, therefore, the difficulty of handling the apparatus, and as yet it has only been used when the conditions were very suitable, as one serious fall would break up the machine.

Nevertheless the results up to now are very promising, and in calm weather Herr Lilienthal has been able to considerably prolong his flights. When, with the ordinary *sailing* machine, he would have come naturally down to the ground, he has found that an occasional flapping of these wings has helped to sustain him a longer time in the air, and to consequently cover greater distances.

Herr Lilienthal has shown now, that, with the simple sailing machine, flights can be made without any great risk. It would be good for the future progress of this mode of sailing if those interested in it, and who have the time and money, would take it up and pursue it further. What is wanted now is experience, and this can only be obtained by the co-operation of many workers.

PETERS—DENZA—RANYARD.

ASTRONOMICAL science has lost three of its votaries during the present month. Dr. C. F. W. Peters died on December 2, and Father F. Denza, as well as Mr. A. C. Ranyard, passed away on Friday last.

Dr. Carl Friedrich Wilhelm Peters, Director of the Königsberg Observatory, died on December 2, after a protracted illness. He was born on April 16, 1844, at the Pulkowa Observatory, where his father, Prof. C. A. F. Peters, held an appointment under the Russian Government. In 1849 his father was appointed to the Chair of Astronomy at Königsberg, and in 1854 he was made Director of the Altona Observatory, which was afterwards transferred to Kiel. The son studied astronomy and mathematics at Berlin, Kiel, München, and Göttingen, and was placed on the staff of the Hamburg and Altona Observatories. Between 1869 and 1872 he made some valuable pendulum observations, chiefly for the Prussian Government. As Privatdocent at Kiel University he undertook a long series of chronometer tests for the German Navy, in the course of which he proved that they are influenced by changes of humidity as well as by changes of temperature. In 1880, upon the death of his father, he edited the *Astronomische Nachrichten* for a year, after which he was appointed Extraordinary Professor at Kiel University. In 1883 he undertook the direction of the Naval Chronometric Observatory at Kiel, whence he proceeded in 1888 to the directorship at Königsberg, where he terminated a useful and laborious career.

Father F. Denza died at Rome on the 14th inst. from cerebral hæmorrhage. He was well known to the scientific world by his works in astronomy, meteorology, and terrestrial magnetism, and at the time of his death was President of the Italian Meteorological Society, and Director of the Observatory at Moncalieri, which he founded in 1859, as well as of the Vatican Observatory, which was established by the Pope in 1891. It was owing to the untiring energy of Father Denza that the *Corrispondenza Meteorologica Italiana* was established in connection with the Alpine Clubs, and that the results of observations at a large number of stations in the Alps and Apennines have been regularly published in the organ of the Italian Meteorological Society. He was elected an honorary member of the Royal Meteorological Society in 1870.

In astronomy his chief work relates to the observation of meteors. For several years he issued instructions to observers of meteors previous to every important shower, and he published numerous tables and papers on the observations carried on under his guidance, both in *Comptes-rendus* and the *Monthly Notices* of the Royal Astronomical Society. When the Directorship of the Vatican Observatory was taken by Father Denza a very comprehensive programme was drawn up, embracing investigations in meteorology, terrestrial magnetism, geodynamics, and astronomy. Observations in each of these branches of knowledge have increased in number every year since then, and the fourth volume of the *Pubblicazioni* of the Observatory, received by us on the same day as the news of Father Denza's death, is even greater in bulk than any of the previous ones. Father Denza was chiefly instrumental in making the Vatican Observatory one of those co-operating in the production of the photographic star-chart. He devoted his best energies to the advancement of the scheme, and to the progress of astronomical photography. The reports to which reference has been made, contain evidence of his knowledge of what had been done in other astronomical observatories, and of his ability to direct and further the advancement of celestial photography. His services to astronomy have earned for him an honoured place in our memory of the sons of science.

Mr. Ranyard was born in 1845. He was educated at Cambridge University, and was called to the Bar in 1871. He was one of the founders of the London Mathematical Society, of which he was originally joint secretary with Mr. George De Morgan, Prof. Augustus De Morgan being president. He became a Fellow of the Royal Astronomical Society in 1864. In 1870 he was assistant secretary of a joint committee of the Royal Society and the Astronomical Society, which organised the expedition despatched to Sicily, Spain, and Oran to observe the total solar eclipse of December 21. On his return to England he undertook to assist Sir G. B. Airy in the preparation of the report of the observations of the total eclipses both of 1870 and 1860. Ultimately Sir George Airy transferred the work entirely to Mr. Ranyard, and in 1880 the report was published by the Royal Astronomical Society as vol. xli. of its "Memoirs." He observed the total eclipse of July 29, 1878, from Cherry Creek, near Denver, Colorado, and the total eclipse of May, 1882, from Sohag, in Upper Egypt. In addition to papers on the corona and matters connected with physical astronomy, he also published papers on the "Early History of the Achromatic Telescope," and on "Photographic Action." In conjunction with Lord Crawford and Balcarres, he undertook in 1872 a series of experiments on photographic irradiation; and in 1886 he demonstrated by a series of experiments that the intensity of photographic action varies directly as the brightness of the object photographed, and directly as the time of the exposure. The "Old and New Astronomy," designed by Mr. Proctor, was completed in 1892 by Mr. Ranyard, who contributed to it some very important sections on the structure of the stellar universe.

NOTES.

THE newly-discovered gas is to be the subject of a discussion at a meeting of the Royal Society on January 31, when Lord Rayleigh and Prof. Ramsay will present their paper. This will be the first meeting under a resolution of the Council of the Society passed last session, whereby certain meetings, not more than four in number, are to be devoted every year, each to the hearing and consideration of some one important communication, or to the discussion of some important topic.

AT the request of the Ottoman Government, Dr. G. Agamennone, of the Italian Meteorological and Geodynamic Office, will shortly proceed to Constantinople to found there a seismological observatory of the first order. Amongst the instruments to be erected are an Agamennone seismometrograph and a tromometer similar to those in use in the principal Italian observatories. The tromometer will be provided with a photographic recording apparatus, and is specially adapted for registering the long-period pulsations from distant earthquake centres.

DIRECTORS of Botanic Gardens abroad will be glad to know that a list of seeds of hardy herbaceous annual and perennial plants and of hardy trees and shrubs which, for the most part, have ripened at Kew during the year 1894, is given in an appendix, recently issued, to the *Kew Bulletin*. These seeds are not sold to the general public, but are available for exchange with Colonial, Indian, and Foreign Botanic Gardens, as well as with regular correspondents of Kew. No application, except from remote colonial possessions, can be entertained by the Director of the Royal Gardens at Kew after the end of March.

THE death is announced of Pafnutij Tchebitchef, the eminent Russian mathematician. He was a Foreign Member of the Royal Society, and an Associé Étranger of the Paris Academy of Sciences.

DR. F. B. HAWKINS died on December 7, at the great age of ninety-eight. He was elected a Fellow of the Royal Society sixty years ago, and was one of the oldest members of the medical profession.

THE *Lancet* understands that the Premier has consented to receive a deputation to advocate the formation of a University for London on the lines recommended by the recent Royal Commission. The meeting will probably take place about the middle of January.

THE Paris correspondent of the *Chemist and Druggist* reports that the Municipal Council have presented fifteen hundred francs to the École Normale Supérieure, to erect a bust of M. Pasteur in that college. The Council have also voted in favour of changing the name of the rue d'Ulm to that of "rue Pasteur."

AT the invitation of the associated scientific clubs of Berlin, a numerous assembly met on Friday last in order to commemorate the great services rendered to science by the late Prof. von Helmholtz. The German Emperor and Empress, and many Ministers and members of Parliament, attended the ceremony.

OUR Cambridge correspondent informs us that the Coutts Trotter Studentships in Physics at Trinity College have been awarded for two years to Mr. I. L. Tuckett, and for one year to Mr. S. W. J. Smith, both being scholars of the College.

THE Council of the Marine Biological Association has appointed Mr. E. J. Allen to be director of the Plymouth laboratory, in succession to Mr. E. J. Bles, who lately resigned that position. Mr. Allen is a pupil of Prof F. E. Schultze, of Berlin, and has been engaged in researches upon the cœlomic and nervous systems of Crustacea, some interesting results of which were recently noticed in our columns.

ARRANGEMENTS have been made to begin the new series of *Science* on the first day of the new year, under wholly different direction and auspices. The New York *Nation* says that the paper will hereafter be under the control of a representative editorial committee, and will undertake to report on the progress of science for men of science. The managing committee is constituted as follows:—Mathematics, Prof. Simon Newcomb; Mechanics, Prof. R. S. Woodward; Astronomy, Prof. E. C. Pickering; Chemistry, Prof. Remsen; Physiography, Prof. W. M. Davis; Palæontology, Prof. O. C. Marsh; Morphology, Prof. W. K. Brooks; Zoology, Dr. C. Hart Merriam; Botany, Prof. N. L. Britton; Hygiene, Dr. J. S. Billings; Physiology, Dr. H. P. Bowditch; Ethnology, Dr. J. W. Powell; Anthropology, Dr. D. G. Brinton; Psychology, Prof. Cattell.

THE Organising Committee of the International Geographical Congress have issued an invitation circular to members of geographical societies, and all who take an interest in any of the various aspects of geography, to attend the meetings of the Sixth International Geographical Congress, which will be held in London from July 26 to August 23, 1895. The subjects to be dealt with at the Congress will be grouped under the following heads:—(1) Mathematical Geography; (2) Physical Geography, including Oceanography and Geographical Distribution; (3) Cartography; (4) Exploration; (5) Descriptive Geography; (6) Historical Geography; (7) Applied Geography, including Anthropo-Geography; (8) Education. Intending contributors of papers should send in their communications (written in English, French, German, or Italian) before the end of next April. An exhibition of instruments, maps, globes, photographs, and other objects representative of the present state and past history of geographical science, will be held in connection with the Congress.

DR. E. DE TELLENBERG writes to us, from the Natural History Museum at Berne, with reference to a communication made by Sir John Lubbock to the Geological Society, on November 7 (NATURE, vol. li. p. 94), on some nummulites from the valley of Lauterbrunnen at Murren. Sir John Lubbock remarked that "the find will necessitate a substantial correction of the geological map"; but Dr. de Tellenberg says that the nummulitic layer described was known long ago, and is shown on several geological maps; while the conclusion, that the rock is "not Malm, but Eocene," appears to have been arrived at fifty years ago.

IN a presidential address to the members of the Tyneside Naturalists' Field Club, just received, Prof. G. S. Brady gives an interesting sketch of the present state of fisheries and fish-culture in Great Britain. He describes a visit to Mr. Armistead's successful salmon and trout hatchery near New Abbey, and recommends the foundation of a hatchery on the Northumberland coast to aid in keeping up and improving the supply of sea-fish, and of a biological laboratory attached to it for the scientific study of the marine fauna of the neighbourhood. We hope that everyone interested in the maintenance of our sea-fisheries, and in the study of marine biology in the north-east of England, will cordially assist in the realisation of this timely proposal. A work of this kind, as Prof. Brady suggests, comes fairly within the powers of the County Councils, which have already shown a commendable care for the interests of agriculture, and a desire generally to help forward technical and scientific education.

THE current number of the *Bollettino mensuale* of the Italian Meteorological Society contains a summary, by Profs. A. Bartoli and E. Stracciati, of their determinations of the absorption of solar radiation by fog and by cirrus clouds. The investigations were very carefully conducted, and the results are therefore of considerable interest. It was found that a veil of cirrus was able to intercept as much as 30 per cent. of the sun's rays; while a slight fog, equally diffused in all directions, intercepted from 58 to 92 per cent. of the solar rays, which would have been transmitted with a perfectly clear sky. Full particulars of the numerous experiments made by the authors since the year 1885 will be found in the *Proceedings* of the Royal Institute of Lombardy of July 19 last.

THE Pilot Chart of the North Atlantic Ocean shows that the weather over that ocean during November was very severe. From the 9th to the 23rd of the month there were only two days of good weather between Newfoundland and this country. An appendix to the chart gives the synoptic weather conditions of the North Atlantic north of the 35th parallel for six consecutive days (September 28 to October 3) for the hour of Greenwich noon, showing the positions and behaviour of the various storms which were prevalent at that time. The excellent system adopted by the United States authorities for the collection and discussion of observations made at sea has enabled them to produce this synoptic chart so soon after date. We notice, however, that in the description of the storm signals used in various countries the "cylinder" or "drum" is referred to as now being employed by this country, but as a matter of fact it has not been used for many years.

IN *La Nature* of the 1st instant, M. de Nansouty gives an account of some interesting experiments by M. Kœchlin on the Eiffel Tower, with the view of measuring the force of the wind by the use of metal blocks whose resistance had been previously tested in the laboratory by means of compressed air. During the storm of November 12 last, the velocity anemometers registered 100 miles in the hour, and according to the formula used for the conversion of velocity into pressure, the blocks indicating a pressure of 200 kilograms ought to have been overturned, but only those indicating a pressure of 100 kilograms were displaced. From this, M. Kœchlin concludes that the formula gives results about 40 per cent. too high. It appears to us that the experiments afford a remarkable confirmation of Mr. W. H. Dines's recent investigations of anemometrical constants, in which he found that the usual theory of the cups moving with one-third of the wind's velocity gave values which were about 30 per cent. too high. Experiments very similar to those of M. Kœchlin were made by Mr. G. Dines some years ago, under less favourable conditions. but with nearly similar results.

A PICTURE-PUZZLE of a remarkable kind appears in the *Zoologist* for December. It is a reproduction of two photographs of a Little Bittern, showing the strange attitudes assumed by the bird to favour its concealment. One of the figures shows the bird standing in a reed-bed, erect, with neck stretched out and beak pointing upwards; and in this position, it is difficult to distinguish the bird at all from the reeds. The eye is deceived in a similar manner when the bird is crouching against a tree-stump at the river-side. Mr. J. E. Harting thinks that the curious attitudes adopted by the bird, on finding itself observed, are assumed in the exercise of the instinct of self-preservation. He mentions a similar habit, observed and described by Mr. W. H. Hudson, in the case of a South American Little Heron, which frequents the borders of the La Plata, and is occasionally found in the reed-beds scattered over the pampas. Without the aid of dogs, it was found impossible to secure any specimens of this bird, even after marking the spot where one had alighted.

THE architecture and sculpture of Gastropod shells has often arrested the attention of naturalists, for, in spite of the infinite variety of form assumed by the shell, it is in most cases extremely difficult to perceive any special utility in the nature of the modifications. A paper by Mr. W. H. Dall, however, in a recent number of the *American Naturalist* (No. 335), certainly tends to clear up two sets of these phenomena, viz. the ridges or plications of the columella, and the liræ or teeth of the outer lip. The author shows that among the fusiform rachiglossa the retractor or columellar muscle is longer, and attached deeper within the shell in the plicated (*e.g. Mitra*) than in the non-plicated forms (*e.g. Fusus*). The result of this is that in the former the mantle during contraction is withdrawn into a part of the shell too narrow to admit it in its normal shape. The mantle must wrinkle longitudinally; and the longitudinal shelly ridges on the pillar and towards the aperture of the shell are the mechanical consequences of this plication of the secreting surface. Similarly in forms possessing a very extensive mantle (*Volutidæ*, *Cypræidæ*) it may be noticed that the outer lip of the shell is toothed chiefly in those types in which the aperture is small, and that the denticulation is less marked as the aperture becomes larger. This is attributed by Mr. Dall to the fact that as the aperture becomes reduced the mantle must become increasingly wrinkled at its exit from the shell, thus causing the deposition of teeth and liræ on the outer lip (*c.f. Cypræa*). If these features fall under Prof. Lankester's category of "responsive characters," the question arises whether the whole molluscan shell, so far as its shape and sculpture is concerned, is not simply a combination of such characters.

THE first number of a series of hand-lists of the collections of living plants cultivated in the Royal Gardens, Kew, has just been received. This part, which contains a list of *Polypetalæ*, shows that the complete catalogue will be of the highest service in helping to establish a uniform system of nomenclature. An immense number of "trade" or "garden" names have been reduced to their proper synonyms, and as the woody plants (shrubs and trees), grown in the open air, are particularly liable to confusion in gardens, and in nurserymen's catalogues, the present list is most acceptable. It can easily be understood that the list "represents the work of many years, and has only been accomplished with considerable labour." From the preface we learn that, of the twenty thousand species and distinct varieties of plants cultivated at Kew, three thousand are hardy shrubs or trees. The first catalogue of plants cultivated at Kew, published in 1768, contained 3389 species, of which 488 were hardy trees and shrubs. The two Aiton's published similar lists, but that issued by the younger Aiton early in this century, and containing about eleven thousand species, was the latest comprehensive list of plants in cultivation at Kew, though lists of special collections have been published from time to time. The great importance of the series of hand-lists, which Mr. Thiselton-Dyer has instituted, will therefore be at once understood.

THE twenty-sixth volume of the *Memoirs* of the Russian Geographical Society (General Geography) contains an important work by Prof. Mushketoff and A. Orloff, being a catalogue of all the earthquakes which are known to have taken place in the Russian empire and the adjoining territories of China, Turkestan, Persia, and Asia Minor from the year 596 B.C. till the year 1887. The list comprises no less than 2400 separate earthquakes, of which 710 took place in China, 569 in East Siberia, 36 in West Siberia, 202 in Central Asia, 590 in Caucasia, 121 in North Persia and Asia Minor, and 188 in European Russia and Finland. These figures alone, if compared with those for China in the catalogues of R. Mallet, A. Perrey, and Fuchs, give an idea of the richness of the Russian catalogue. As to Russia, Siberia, and Turkestan, the catalogue is replete with entirely new data. Most of the earthquakes of the last two centuries, for which we possess full accounts, given by careful observers, are described at some length, and some of the descriptions, especially for the earth tremors of Shemakha, Lake Baikal, and Turkestan, are of great value. A map showing the distribution of the earthquakes over the territory, and diagrams showing their frequency during the different months, accompany this most valuable work.

A PAPER on the various more or less phantastic forms assumed by combinations of alkalies with oleic acid when brought into contact with water, is contributed to the current number of *Wiedemann's Annalen*, by Dr. G. Quincke. Oleic acid with little alkali, or containing an acid oleate of an alkali in solution, form in much water hollow spheres, globules, and foam, with walls of liquid oleic acid. The hollow spaces are filled with aqueous soap solution. When more water is added, the walls are covered with a solid skin of the acid oleate, which may then become quite liquid again by decomposition into liquid oleic acid and aqueous soap solution. The periodic flow of soap solution at the surface separating liquid oleic acid and water produces vortex motions, which may be made evident with methylene blue or other colouring matter. More hollow spheres and bubbles of oleic acid are formed, which are arranged by the capillary forces on the larger bubbles in definite positions, such as straight lines, circles, and ellipses. Dr. Quincke points out the remarkable analogy between this arrangement and the configuration of various small portions of the stellar universe, such as portions of Orion, Virgo, and Coma Berenice's, and recalls Plateau's experiments with weightless oil spheres illustrative of the generation of the solar system. He also emphasises the fact that the protoplasm of the organic world shows a structure and motions similar to those of oil foam with liquid or solid surfaces.

UNDER the title, "Science Teaching; an Ideal, and some Realities," Mr. H. G. Wells delivered a lecture at the College of Preceptors last week. Much attention is now being given to the methods of science teaching in our elementary schools and colleges, and Mr. Wells' views on the subject are sound enough to be taken into consideration. In the course of his lecture, he pointed out that a rational course of science should grow naturally out of kindergarten. This should lead to object-lessons proper, and demonstrations in physics and chemistry may be made to grow insensibly, without any formal beginning, out of such lessons. The best, about the only permanently valuable, preparation for a scientific calling that can be given to a boy in a secondary school, is the broad basis of physics and chemistry led up to in this way.

THE 1895 *Annuaire* of the Montsouris Observatory—the Observatory of the Paris Municipal Council—has been published. Though the observations made at the Observatory have special reference to the climatology and hygiene of Paris, researches into the domains of pure science are carried on. M. Léon Descroix has charge of the physical and meteorological service, and M. Albert-Lévy of the chemical part of the work. This department includes the study of the variations in the chemical composition of the air in various parts of Paris, and of rain and river waters. The third branch of the work, dealing with micro-organisms, is under the direction of Dr. Miquel, who contributes to the *Annuaire* his sixteenth memoir on the organic matter found in air and water.

THE papers read at meetings of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, and the Tyneside Naturalists' Field Club, during the past two years, have just been published in the Society's *Transactions*, vol. xi. part ii. Among them is an address by the President, Prof. G. S. Brady, F.R.S., on the life-history and character of some internal parasites, and a lecture on parasitism in plants and animals. The latter forms one of a series of reports of five lectures given in the Museum of the Society; the others being "On the Egg," by Dr. D. Embleton; "Frogs and Tadpoles," by Prof. M. C. Potter; "The Structure of Timber," by Dr. W. Somerville; and "Germs," by Mr. H. De Haviland. The Society appears to be in a far more flourishing condition than most provincial societies.

SEVERAL new editions of scientific books have been received during the past week. Prof. Richard Hertwig's "Lehrbuch der Zoologie" (Gustav Fischer, Jena) is one of these. The original edition was reviewed in NATURE in June 1893 (vol. xlviii. p. 173), and we have nothing to add to the remarks then made, except that the work has been improved by revision. We are glad to see that Mr. Cumming's "Introduction to the Theory of Electricity" (Macmillan) has reached a fourth edition. The chief additions to the new issue are articles upon the magnetic circuit and on the dynamo. "Symbolic Logic," by Dr. John Venn, F.R.S. (Macmillan), has survived the prejudices of anti-mathematical logicians, for a second edition, revised and rewritten, has just appeared. Finally, Messrs. Whittaker and Co., have issued a second edition of "The Electro-Platers' Handbook," by Mr. G. E. Bonney. This useful manual has been enlarged by an additional chapter on electrotyping, and by a number of short sections on new methods of interest to amateurs and young students of electro-metallurgy.

A BULLETIN (really a volume of 259 pages), by Mr. J. E. Spurr, has come to us from the Geological and Natural History Survey of Minnesota. The subject is "The Iron-Bearing Rocks of the Mesabi Range in Minnesota," and the author treats it from many points of view. A number of reproductions of the appearances presented by thin sections of the rocks when microscopically examined, accompany the memoir. The matter is not merely descriptive of the general structure and characteristics of the Mesabi iron-bearing rocks; if it were, it would only be of local interest. Space is given to the statement of theories to account for the origin of rocks of the kind described—a subject which is still one of doubt, discussion, and speculation. In this connection the origin of glauconite is dealt with. An examination of a thin section, with a view to finding whether the forms in which the glauconitic grains sometimes occur have any resemblance to organic forms, led to a negative result. Mr. Spurr thinks it possible, however, that further study of more favourable sections may result in finding traces of the organisms which possibly once existed in the rocks investigated. His work throws new light upon several perplexing problems in economic geology.

ANHYDROUS hydrogen peroxide has at last been isolated by Dr. Wolffenstein in the laboratory of the Technischen Hochschule at Berlin, and the somewhat surprising fact demonstrated that this substance, which has hitherto been regarded as possessing but little stability, is capable of actual distillation with scarcely any loss under reduced pressure. In attempting to concentrate solutions of hydrogen peroxide *in vacuo* by the method of Talbot and Moody, and also in the open air upon the water bath, a solution as strong as 66 per cent. H_2O_2 was obtained, but with a loss of over 70 per cent. of the original amount of peroxide employed. Moreover, it was found that when the common commercial 3 per cent. solution is concentrated, the percentage of H_2O_2 may be brought up to 45 without the loss of any considerable quantity of the peroxide by volatilisation, but that as the concentration continues to rise above this limit the volatilisation of the peroxide increases at a very rapid rate. For the great loss was proved not to be due to decomposition, but to actual vapourisation of the substance. Evidently hydrogen peroxide is remarkably stable at the temperature of a water bath. An attempt was therefore made to actually distil it under reduced pressure. A quantity of commercial peroxide which had been further concentrated until it contained about 50 per cent. H_2O_2 was first purified from all traces of suspended impurities, and at the same time still further concentrated, by extraction with ether; after evaporation of the ether the solution was found to contain 73 per cent. H_2O_2.

This solution was then submitted to distillation at the temperature of the water bath and under the reduced pressure of 68 m.m. of mercury. The distillate was received in two fractions, boiling at 71°–81° and 81°–85° respectively. The first fraction contained 44 per cent. H_2O_2, while the latter was found to contain no less than 90·5 per cent. Upon again fractionally distilling the latter product, a large proportion distilled at 84°–85°, and this fraction proved to be practically pure H_2O_2, containing over 99 per cent. of the peroxide. The liquid thus isolated is a colourless syrup which exhibits but little inclination to wet the surface of the containing vessel. When exposed to the air it evaporates. It produces a prickly sensation when placed upon the skin, and causes the appearance of white spots which take several hours to disappear again. As regards the much-discussed and disputed question of the reaction of hydrogen peroxide towards litmus, Dr. Wolffenstein finds that even when the pure liquid is made strongly alkaline with soda and again distilled, the distillate exhibits strong acid characters, so that the acid nature of hydrogen peroxide must be regarded as fully established. It is finally shown that the use of ether in assisting the concentration is by no means essential. Ordinary commercial 3 per cent. peroxide can be immediately subjected to fractional distillation under reduced pressure, and a fraction eventually isolated, consisting of the pure substance boiling at 84°–85° under a pressure of 68 m.m.

THE additions to the Zoological Society's Gardens during the past week include a Common Fox (*Canis vulpes*), British, presented by Mr. Harold von Löhr; a Spotted Ichneumon (*Herpestes nepalensis*) from India, presented by the Misses Violet and Sylvia Brockelbank; two Curlews (*Numenius arquata*), British, purchased.

OUR ASTRONOMICAL COLUMN.

SECULAR VARIATIONS OF THE INTERIOR PLANETS.—As far back as 1859, Leverrier discovered that the movement of the perihelion point of the orbit of Mercury was greater than could be accounted for by the action of all the known planets, and he attributed this to the effect of a group of unknown bodies circulating between the orbit of Mercury and the sun. Prof. Newcomb has recently gone over the ground again, and the results of his work are given in *Comptes-rendus* of December 10. A brief statement of the tentative conclusions arrived at was given in these columns on November 29 (p. 114). From a discussion of a vast number of observations he has redetermined the secular variations for the orbits of Mercury, Venus, the Earth, and Mars, and he has computed the masses of Mercury, Venus, and Jupiter from the periodical perturbations which they produce; the adopted value of the earth's mass is deduced from the parallax 8″·80, and for Mars the adopted mass is that derived from observations of the satellites. It is then shown that with these masses the calculated values of the secular variations differ from the observed ones, the divergences being especially great in the movements of the perihelia of the orbits of Mercury and Mars, and of the node of Venus. Two explanations of the differences are open to us: (1) It may be supposed, as suggested by Prof. Asaph Hall, that the law of gravitational attraction is not strictly true, and that the attractive force of the sun varies inversely as the distance raised to the power of approximately 2·000000 1574; (2) they may be attributed to the influence of unknown masses of matter.

At first sight, the second hypothesis seems preferable, as it involves no departure from an accepted law, and because it is the only one which will explain all the secular variations, while on the first hypothesis the perihelia would alone be affected. If there are unknown bodies between Mercury and the sun, Prof. Newcomb shows that in order to produce the observed effects, their mass must be great enough to produce a sensible ellipticity in the sun's figure; and as this has not been detected, he prefers to place these unknown bodies between the orbits of Mercury and Venus. He has computed the elements of an orbit which would reduce all the discrepancies between observed and calculated values of the secular variations to less than the probable errors, the mean distance being 0·48, and the mass 1/37,000,000th that of the sun. At the same time, Prof. Newcomb regards this result more as a curiosity than as a reality, as it seems improbable that such a group of bodies should have escaped discovery.

Returning to the other hypothesis, he finds that if we accept Hall's modification of the law of gravitation, which accounts for the movements of the perihelia, the variations of the other elements can all be explained by slightly changing the value of the earth's mass. The new value corresponds to a solar parallax of 8″·77. Although by no means regarding the latter hypothesis as established, Prof. Newcomb is inclined to adopt it provisionally.

IRREGULARITIES IN VARIABLE STARS.—In a summary of the observations of variable stars of long period, made by W. Maxwell Reed at Harvard College Observatory and the Abbot Academy (*Astron. Journ.* No. 330), the importance of studying the irregularities in the light curves is strongly insisted upon. The observations indicate numerous "stand-stills," or notches in the light-curves, and these are believed to be secondary phases produced by additions of light at those points. "A record of over ten years for T Cephei gives ten more or less well-defined stand-stills. The mean period is about twenty days less than that of the variable (about 383 days)." From studying these and other variables, Mr. Reed is inclined to believe that "the light-curve, in some cases at least, is the sum of two or more curves—each component curve having a different range, period, and character from the others. By such a hypothesis one can account for the changes in period and range of a variable, and the presence of "stand-stills" and secondary phases. Unfortunately, there is not enough evidence yet to give the elements of the two or more component curves for T Cephei." It will be remembered that Mr. Lockyer has also seen the necessity for supposing more than one source of variation in many cases, and some of his examples of the peculiar curves produced by integrating two perfectly regular ones were given in our columns four years ago (NATURE, vol. xlii. p. 550). With Mr. Reed we regret that less attention has been given by observers to the character of the light-curves of these variables, than to the determination of the maxima and minima.

THE RADCLIFFE CATALOGUE.—The new star catalogue recently issued by Mr. Stone contains the positions of 6424 stars for the epoch 1890, deduced from observations made with the transit circle at the Radcliffe Observatory between January 1, 1881, and December 31, 1893. Up to 1887 a considerable number of observations were made for the determination of systematic errors of the instrument and for errors of the refraction tables. Since then the observations have been more exclusively directed to obtaining the positions of stars for well-distributed zero-points between the equator and N.P.D. 115°, in continuation and completion of the work carried out under Mr. Stone's direction at the Cape of Good Hope between the years 1870 and 1879. The catalogue gives the positions of all stars down to seventh magnitude between the equator and N.P.D. 115°, except those in clusters; of fainter stars to fill existing lacunæ; and of many stars of greater N.P.D. than 115° for comparison with the Cape catalogue of 1880. Many stars north of the equator are also included. The Cape catalogue and the present one together give a series of well-distributed zero-points for the whole southern hemisphere. With reference to future meridian work, Mr. Stone remarks: "From the facilities which photography affords for the rapid filling in of the positions of the fainter stars on a photographic plate, when those of a sufficient number of zero-points on the plate have been otherwise fixed, it would appear that the efforts of meridian observers will, for the future, be most advantageously directed to this class of stellar work." The catalogue includes estimates of proper motions as well as the usual constants, and there are also copious notes relating to the double and variable stars. The early appearance of a catalogue entailing such a vast amount of computation does great credit to the very limited staff of the observatory.

"L'ASTRONOMIE."—The decease of this monthly journal of popular astronomy is announced in the December number. For thirteen years M. Flammarion has conducted *L'Astronomie*, and has used it to popularise, and extend the study of, astronomical science, and now it dies from "difficultés d'administration." The Société Astronomique de France proposes to attempt to fill the gap by issuing their *Bulletin* monthly instead of quarterly, as heretofore.

ON THE USE OF THE GLOBE IN THE STUDY OF CRYSTALLOGRAPHY.[1]

IN modern treatises on crystallography, the crystal is imagined projected radially on the surface of a sphere, and the spherical triangles so obtained are dealt with by spherical trigonometry. Problems in astronomy and mathematical geography are also commonly dealt with by the methods of spherical trigonometry. But they can also be dealt with completely by the method of graphical construction on the surface of a sphere where the angles and arcs are directly measured with a divided circle; and the use of spherical trigonometry is dispensed with. Many years ago it occurred to the author that what eliminated the use of spherical trigonometry in the one case might eliminate it in the others: hence the idea of the use of the globe in the study of crystallography. Various arrangements of globe and circles were described and exhibited. The usual method of mounting globes on a polar axis, round which it can revolve inside a metal meridian, supported in its turn at right angles to a horizontal circle or equator, was found to be inconvenient. It is necessary to be able to reach every part of the globe, and to have it steady for drawing, and the fixed circle and axes stand greatly in the way of this. The instrument found most generally useful was a black globe, along with a system of brass circles, divided into degrees, which can be applied directly and exactly to any part of its surface. The system of brass circles is called the *métrosphère*, invented by Captain Aved de Magnac, of the French Navy, and published by E. Bertaux, of Paris. With this instrument every problem in the geometry of crystals can be solved with ease and accuracy by graphic construction alone.

The various manipulations occurring in the use of the globes were described and illustrated. In the practical determination of a crystal, the inclinations of its faces are observed with the goniometer. From these observations, treated usually by the methods of spherical trigonometry, the elements of the crystal, namely, the inclination of its axes and the proportion of its parameters, are deduced. The process is then reversed, and the elements found are assumed, and from them the inclinations of the faces are calculated. The usefulness of the globe was illustrated by demonstrating how these two processes can be carried out by simple graphical construction. On the globe, the face of a crystal is represented by its pole, or the point where the radius of the sphere, which is perpendicular to the face, pierces the surface of the sphere. The angle between two faces, measured by the goniometer, is the angle contained between their normals. It is therefore ready to be transferred directly to the globe on which it is entered as an arc. In doing so, any point on the globe is taken as the pole of the face from which a start is made. From this a great circle is drawn in any direction. When the first angle has been measured on the goniometer, it is laid off on the globe as an arc, of an equal number of degrees, along this great circle, and from the initial fixed point. The poles of the first pair of faces are situated at the extremities of this arc, which becomes the *base line* of the survey of the crystal. By triangulation from it, the angles being supplied by the goniometer, the positions of the poles of all the faces are placed as points on the globe.

The intersection of a face with the surface of the globe is a circle, which may be described on it with a pair of compasses, taking the pole of the face as centre. The circles in which any two faces, which are not parallel, meet the sphere, cut each other in two points. If these points be joined by the arc of a great circle, we obtain the projection of the edge which the two faces make on meeting. It is perpendicular to the great circle passing through the poles of the two faces. If it be carried parallel to itself to the centre of the sphere, it coincides with a diameter, and its poles are indicated by points on the globe. When the operation has been repeated with all the edges, we have a second group of points on the globe, which catalogues the edges occurring on the crystals.

If the circles of intersection, with the surface of the sphere, of any three faces, not in the same zone, be considered, the arcs connecting each pair of intersections meet in a point which is the projection of the *corner* formed by the three faces which meet there. A third group of points, representing corners, is thus obtained on the globe, and the characteristics of the crystal are exhausted.

[1] Abstract of a Paper read before the Chemical Society, December 6, 1894, by J. Y. Buchanan, F.R.S.

If the corners be carried parallel to themselves to the centre, they find themselves already represented by the intersections of the diameters representing their edges. If the similar poles of any such group of diameters be connected by arcs of great circles, a spherical triangle or polygon is marked out, and its area compared with that of a hemisphere is a measure of the corner, just as the arc is the measure of the angle which it subtends. The secondary figures thus described on the surface of the sphere are always different from the primary ones. Thus the corners of the cube, when collected at and radiating from the centre of the sphere, delineate the regular octahedron, which in its turn, when similarly treated, delineates the cube. From this point of view they are reciprocal inversion forms.

Having got a complete projection of it on the globe, the crystal can be studied. It can be referred with equal ease to any system of coordinates and to any number of different systems; it is only necessary to shift the *métrosphère* over the surface of the globe. In fact, there is now no question touching the geometry of the crystal which cannot be directly answered after making one or more simple measurements; and the distinction between easy questions and difficult ones has almost disappeared.

The projection of the crystal has been constructed from supposed observed angles on the goniometer; but it is equally easy to construct it from its crystallographic specification—that is, the inclination of the axes and the proportion of the parameters.

The projections, of the normals to the faces, or the coordinate planes, are found by constructions on these planes. These positions are marked on the sphere by the points on the coordinate circles where they meet its surface. A great circle drawn through any one point, at right angles to the coordinate circle, contains the pole of the face. It is also contained in another great circle, found in the same way. It is fixed in their point of intersection.

In this way every possible face, permitted by the specification, can be easily and readily placed on the sphere by its representative pole; and the angles between every pair can be at once taken off with a pair of compasses or a tape. In a few minutes a complete catalogue can be made of the angles which each face makes with every other one. The advantage of this is particularly apparent in the oblique systems, which on the globe are dealt with as readily and as easily as those of the regular system.

In conclusion, the author alluded to other uses of the globe, where it does easily, and without fatigue, work which can be done in no other way without great labour; and he pointed out an important indirect advantage, gained by its use, in the education of the sense of direction, which is generally only sparingly developed in the mind.

THE USE OF SAFETY EXPLOSIVES IN MINES.

A LARGE committee was appointed by the North of England Institute of Mechanical Engineers in 1888, to investigate and report upon the subject of flameless explosives in relation to their degree of safety in mines. Experiments with various explosives and appliances connected with shot-firing were commenced in 1892 at Hebburn-upon-Tyne, and a number of papers referring to them have been contributed to the Institute's *Transactions*. The first part of the Report of the Committee has just been published, and it clears away many of the doubts and uncertainties connected with the employment of safety explosives in underground workings. Into the details of the experiments we have not space to enter, but the following conclusions deduced from them show the kind of results obtained:—

(1) All the high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, and securite) are less liable than blasting-powder to ignite inflammable mixtures of air and fire-damp. These explosives, however, cannot be relied upon as ensuring absolute safety when used at places where inflammable mixtures of air and fire-damp may be present.

(2) The variable results following upon the detonation of high explosives appear to be due in some measure to defective admixture of, or variation in the proportions of, the ingredients used in the manufacture of the explosive.

In view of the changes from time to time made in the proportions and constituents of high explosives, it seems desirable that this information should be afforded by the manufacturers to the users of the explosive.

(3) In the storage of high explosives, it is desirable that every care should be taken to insure their being maintained in a proper condition. It is also certain that these explosives alter in character with age.

(4) It is essential that similar examinations of the working-places and precautions which are in force in mines where blasting-powder is used, should be rigidly observed when a high explosive is employed.

(5) In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened and not abolished by its use.

(6) All of the high explosives on detonation produce evident flame.

(7) The emission of flame from a blown out shot of a detonated high explosive is not prevented by the quantity or length of stemming used.

(8) In the case of a charge of a high explosive which has missed fire, if a short length of stemming (proved up to 8 inches) has been employed, the charge can be detonated by another cartridge of the explosive and additional stemming being placed in the hole in front of the original stemming.

The experiments were carried out under the direction of Mr. J. L. Hedley, H.M. Inspector of Mines, and Mr. A. C. Kayll, the Engineer to the Committee.

The sincere thanks of mining engineers are due to the Institute for bearing the great expense involved by the experiments, and to the many mining companies, associations, and private firms that have rendered valuable assistance in the matter.

THE UPSALA MEETING OF THE INTERNATIONAL METEOROLOGICAL COMMITTEE.[1]

AT the meetings of the International Meteorological Committee, held at the University of Upsala, in August, the secretary submitted a brief report, with the questions proposed for discussion. A statement of these, with the decisions, follows :—

International Bureau.—A report was presented by Prof. Hildebrandsson, in which the functions and cost of such a bureau were considered. The committee decided against its establishment.

Agricultural Meteorology.—Upon the proposition of Mr. Scott, it was decided that the methods employed to distribute weather predictions to farmers, and the results of climatological discussions relating to the crops in the various countries, be published.

Establishment of Stations for Cloud Observations.—Prof. Hildebrandsson presented a pamphlet containing a detailed account of the principal methods employed in these investigations. The committee adopted these resolutions :—

Since experience shows that the altitude of clouds can be easily determined with sufficient accuracy, the generalisation of these investigations in all countries is recommended, preferably by the use of the photographic process. Observations of direction and relative velocity should be made at as many stations as possible, and measures of height at a limited number of suitably distributed stations.

The value of these investigations would be greatly increased if made at the same epoch, therefore it is proposed that they be commenced May 1, 1896, and continued for one year.

The stations already promised are situated in Batavia, France, Norway, Portugal, Prussia, Roumania, Russia, Sweden. United States : Blue Hill, and Weather Bureau (six stations).

Cloud Atlas.—The committee appointed at Munich reported slightly modified definitions of some types in the Hildebrandsson-Köppen-Neumayer Atlas, and submitted photographs and pastels for reproduction in the new atlas, as well as instructions for observing clouds. These were adopted by the Permanent Committee after discussion and modification. (See subjoined report.) A special committee, composed of M. Teisserenc de Bort and Prof. Riggenbach, with Prof. Hildebrandsson as chairman, was appointed to publish the atlas, and the choice of the colour of each place, to represent as nearly as possible the natural conditions, was left to its discretion.

More Rapid Transmission of Telegrams.—Dr. Snellen presented a joint report with Dr. Neumayer on this question, in which the necessity of giving the meteorological dispatches precedence over others, by opening a circuit system with the other central bureaus, was urged. The introduction of simultaneous observations in the various countries was deemed necessary. The committee referred the matter to the International Telegraphic Bureau at Berne.

In more or less intimate relation with this question was a proposition by Dr. van Bebber, on the importance of further experiments in tele-meteorography. Dr. Snellen explained the telegraphic transmission of the traces of self-recording instruments by the Olland apparatus, which operates over a short distance at Utrecht.

Scintillation of Stars.—At the request of M. Ch. Dufour, this question, which had been the object of investigations by M. Montigny, of Brussels, was brought before the committee. Further study by him, together with that of M. Ventosa, on the atmospheric movements observed around stars, was encouraged.

Maritime Meteorology.—A proposition of the Russian Admiral Makaroff, on the necessity of an international convention to arrange for the discussion of the data contained in ships' logs, was not approved.

Psychrometric Observations below Freezing.—This question was introduced by Profs. Hildebrandsson and Mohn. The employment of Ekholm's method for the reduction of mean values was recommended, but a report of further investigations was requested.

Exploration of Upper Air.—A resolution received from the *Congrès de la Science de l'Atmosphère*, which had recently met in Antwerp, on the importance of the balloon ascents now being made at Berlin for meteorological purposes, was confirmed in a more general sense.

Next Congress.—It was decided to convene a non-official congress at Paris in September 1896.

THE CLASSIFICATION OF CLOUDS.

In the cloud classification of Hildebrandsson and Abercromby, published in the Hildebrandsson-Köppen-Neumayer Atlas, in 1890, the word "diurnal" is added to the definition of Group D, so that it becomes :—

D. Clouds formed by the diurnal ascending currents.

In this way, the cumulus arising from a mass of aqueous vapour ascending through calm air is distinguished from the nimbus caused by the general ascension of the whole mass of moist air.

With this change the classification of the ten principal forms is :—

(*a*) Detached or rounded forms (most frequent in dry weather).
(*b*) Wide-spread or veil-like forms (wet weather).

A. Highest clouds, mean height 9000 metres.
- (*a*) 1. Cirrus.
- (*b*) 2. Cirro-stratus.

B. Clouds of mean altitude, 3000–7000 metres.
- (*a*) { 3. Cirro-cumulus. 4. Alto cumulus.
- (*b*) 5. Alto-stratus.

C. Low clouds, 1000–2000 metres.*
- (*a*) 6. Strato-cumulus.
- (*b*) 7. Nimbus.

D. Clouds formed by the diurnal ascending currents.
- 8. Cumulus. Top, 1800 metres; base, 1400 metres.
- 9. Cumulo-nimbus. Top, 3000–5000 metres;* base, 1400 metres.

E. Elevated fog, below 1000 metres.
- 10. Stratus.

N.B.—As the heights of the clouds marked * do not agree with the heights of these clouds found at Blue Hill, Mr. Rotch has asked that the altitude of the low clouds be placed below 2000 metres simply, instead of between 1000 and 2000 metres, since the bases of nimbus are frequently below 1000 metres; and also that the superior limit of the tops of the cumulo-nimbus be raised to 8000 metres.

The following are descriptions of the clouds, modified from those in the Hildebrandsson-Köppen-Neumayer Atlas.

[1] Extracted from a report by Mr. A. Lawrence Rotch, in the December number of the *American Meteorological Journal.*

(1) CIRRUS (Ci.).—Isolated feathery clouds of fine fibrous texture, generally of a white colour. Frequently arranged in bands which spread like the meridians on a celestial globe over a part of the sky, and converge in perspective towards one or two opposite points of the horizon. (In the formation of such bands, Ci. S. and Ci. Cu. often take part.)

(2) CIRRO-STRATUS (Ci. S.).—Fine whitish veil, sometimes quite diffuse, giving a whitish appearance to the sky, and called by many cirrus haze, sometimes of more or less distinct structure, exhibiting confused fibres. The veil often produces halos around the sun and moon.

(3) CIRRO-CUMULUS (Ci. Cu.).—Fleecy cloud. Small white balls and wisps without shadows, or with very faint shadows, which are arranged in groups and often in rows.

(4) ALTO-CUMULUS (A. Cu.).—Dense fleecy cloud. Larger whitish or greyish balls with shaded portions, grouped in flocks or rows, frequently so close together that their edges meet. The different balls are generally larger and more compact (passing into S. Cu.) towards the centre of the group, and more delicate and wispy (passing into Ci. Cu.) on its edges. They are very frequently arranged in stripes in one or two directions.

(The term cumulo-cirrus is given up as causing confusion.)

(5) ALTO STRATUS (A. S.).—Thick veil of a grey or bluish colour, exhibiting in the vicinity of the sun and moon a brighter portion, and which, without causing halos, may produce coronæ. This form shows gradual transitions to cirro-stratus, but, according to the measurements made at Upsala, has only half the altitude.

(The term stratus-cirrus is abandoned as giving rise to confusion.)

(6) STRATO CUMULUS (S. Cu.).—Large balls or rolls of dark cloud which frequently cover the whole sky, especially in winter, and give it at times a wave-like appearance. The stratum of strato-cumulus is usually not very thick, and blue sky often appears in the breaks through it. Between this form and the alto-cumulus, all possible graduations are found. They are distinguished from nimbus by the ball-like or rolled form, and because they do not tend to bring rain.

(7) NIMBUS (N.).—Rain clouds. Dense masses of dark formless clouds with ragged edges, from which generally continuous rain or snow is falling. Through the breaks in these clouds there is almost always seen a high sheet of cirro-stratus or alto-stratus. If the mass of nimbus is torn up into smaller patches, or if smaller clouds are floating very much below a great nimbus, the former may be called Fracto-nimbus ("Scud" of the sailors).

(8) CUMULUS (Cu.).—Piled clouds. Thick clouds whose summits are domes with protuberances, but whose bases are flat. These clouds appear to form in a diurnal ascensional movement which is almost always apparent. When the cloud is opposite the sun, the surfaces which are usually seen by the observer are more brilliant than the edges of the protuberances. When the illumination comes from the side, this cloud shows a strong actual shadow; on the sunny side of the sky, however, it appears dark with bright edges. The true cumulus shows a sharp border above and below. It is often torn by strong winds, and the detached parts (Fracto-cumulus) present continual changes.

(9) CUMULO-NIMBUS (Cu. N.).—Thunder cloud; shower cloud. Heavy masses of clouds, rising like mountains, towers, or anvils, generally surrounded at the top by a veil or screen of fibrous texture ("false cirrus"), and below by nimbus-like masses of cloud. From their base generally fall local showers of rain or snow, and sometimes hail or sleet. The upper edges are either of compact cumulus-like outline, and form immense summits, surrounded by delicate false cirrus, or the edges themselves are drawn out like cirrus. This last form is most common in "spring squalls." The front of storm clouds of great extent sometimes shows a great arch stretching across a portion of the sky, which is uniformly lighter in colour.

(10) STRATUS (S.).—Lifted fog in a horizontal stratum. When this stratum is torn by the wind or by mountain summits into irregular fragments, they may be called Fracto-stratus.

INSTRUCTIONS FOR OBSERVING CLOUDS.

At each observation there are to be recorded:—

(1) *The Kind of Cloud*, designated by the international letters of the cloud name, which may be more exactly defined by giving the number of the picture of the Atlas most nearly representing the observed form.

(2) *The Direction from which the Clouds come.*—If the observer remains completely at rest during a few seconds, the motion of the clouds may be easily observed relatively to a steeple or mast erected in an open space. If the motion of the cloud is very slow, the head must be supported. Clouds should be observed in this way only near the zenith, for if they are too far away from it the perspective may cause errors. In this case nephoscopes should be used, and the rules followed which apply to the particular instrument employed.

(3) *Radiant Point of the Upper Clouds.*—These clouds often appear in the form of fine parallel bands, which, by an effect of perspective, seem to come from one point of the horizon. The radiant point is that point where these bands, or their direction prolonged, meet the horizon. The position of this point on the horizon should be recorded in the same way as the wind direction, north, north-north-east, &c.

(4) *Undulatory Clouds.*—It often happens that the clouds show regular, parallel, and equidistant streaks, like the waves on the surface of water. This is the case for the greater part of the cirro-cumulus, strato cumulus (roll-cumulus), &c. It is important to note the direction of these streaks. When there are apparently two distinct systems, as is to be seen in clouds separated into balls by streaks in two directions, the directions of the two systems should be noted. As far as possible, observations should be made on streaks near the zenith to avoid effects of perspective.

(5) *Density and Position of Cirrus Banks.*—The upper clouds frequently take the form of felt or of a more or less dense veil, which, rising above the horizon, resembles a thin white or greyish bank. As this cloud form has an intimate relation to barometric depressions, it is important to note:—

(*a*) The density—
0 meaning very thin and irregular.
1 meaning thin but regular.
2 meaning rather dense.
3 meaning dense.
4 meaning very dense and of dark colour.

(*b*) The direction in which the veil or bank appears densest.

Remarks.—All interesting details should be noted, for example:

(1) On summer days all low clouds generally assume particular forms resembling cumulus more or less. In this case, there should be put under *Remarks*, "Stratus or Nimbus Cumuliformis."

(2) It sometimes happens that a cumulus has a mammillated lower surface. This appearance should be described by the name of "Mammato-cumulus."

(3) It should always be noted whether the clouds appear stationary, or whether they have a very great velocity.

The text of the Atlas is to be in French, English, and German.

ENDOWMENT FOR SCIENTIFIC RESEARCH AND PUBLICATION.[1]

II.

IMMEDIATELY connected with our colleges and universities is another field, in which additional endowments are greatly needed, viz. for fellowships in science for post-graduate studies.

Upon the post-graduate workers the future of science, and the recruits for future teachers and professors, must necessarily depend. In that view the importance of post-graduate endowments in science can scarcely be magnified. The great majority of the young men from whom all the new recruits must be drawn have little or no pecuniary means. After graduating, often through many difficulties, they must face the question of their future calling. They must consider what promise of a reasonable and comfortable support a life devoted to science affords. If this risk should not deter them, still there are many with talents of a high order who would be absolutely unable to proceed further in the advanced scientific studies necessary to qualify them to enter upon remunerative scientific

[1] Address delivered by Mr. Addison Brown, at a meeting of the Scientific Alliance of New York. Reprinted from Smithsonian Report, 1892. (Continued from page 167.)

work, or to obtain situations as professors or assistants, except by the aid of substantial endowments for their support, during the three or four years more of necessary assiduous study.

In the stress of modern life, and in the allurements towards more certain pecuniary results, nothing but such endowments can avert the withdrawal from scientific pursuits of many young men of high promise, whose genius and tastes and ambition strongly incline them to science, and who would be secured to it if this temporary support were afforded.

The endowments of our colleges and universities in aid of post-graduate work in science are much less, I suppose, than is commonly imagined. I find no such support for post-graduate work in science, either at Cornell University, at the University of the City of New York, at Brown University, at Amherst, or even at the Johns Hopkins University. No statement of the endowments of the new Clark University at Worcester has as yet been published. Princeton, though having a hundred under-graduate scholarships, has but one post-graduate fellowship for science; Yale but two—the Silliman and the Sloane Fellowships.

Columbia College has two fellowships expressly restricted to science, viz. the Tyndall Fellowship of 648 dols. annually, and the Barnard Fellowship, before referred to, of about 500 dols. annually. Besides these, however, twenty-four general university fellowships have been established, of 500 dols. each, for post-graduate study, of which eighteen are in present operation. About one-third of these are assigned to science; making now eight for science at Columbia, with probably two more in 1893 or 1894. In architecture, moreover, there are three additional noble post-graduate fellowships at Columbia—the Schermerhorn of 1300 dols. annually, and the two McKim Fellowships of 1000 dols. each, to support study in foreign travel. In the Medical Department, also, there are five valuable prizes for proficiency.

The University of Pennsylvania has the Tyndall Fellowship, before referred to; and, in the Department of Hygiene, an admirable laboratory fitted up by Mr. Henry C. Lea, with a fellowship of 10,000 dols. endowed by Mr. Thomas A. Scott, at present applied to original research in bacteriology.

At Harvard, besides the three Bullard Fellowships of 5000 dols. each, established in 1891, to promote original research in the medical school, there are two post-graduate fellowships restricted to science exclusively, namely, the Tyndall Fellowship of about 500 dols. annually, and the income of the recently established Joseph Lovering Fund, the principal of which is now about 8000 dols. There are also eleven other general fellowships, viz. the Parker, the Kirkland, and the Morgan Fellowships, available for promising graduate students in any branch, of which about five have been usually assigned to science. These fellowships give an income of from 450 dols. to 700 dols. a year. Harvard has also forty-six scholarships available for graduate students, varying in income from 150 dols. to 300 dols. each, of which about seventeen are assigned to science. During the last year, according to the report of Prof. Pierce, the Dean, there were 193 applications for those post-graduate fellowships and scholarships, seventy-one of which were in science. Only one-third of the applicants could receive the aid. The Dean adds:

"The number of appointments is still *very insufficient* to meet demands of promising students who wish to enter the graduate school, and are unable to do so without assistance." (Report Harvard Coll. 1891, p. 92.) The tables published by him indicate that a considerable number of those not aided withdrew from science; and that many others who were entered for the first year in the graduate school would, if not aided, afterwards leave. It is gratifying to observe the further fact, so encouraging also for the young graduates who wish, if possible, to enter upon a scientific career, that all who had enjoyed these fellowships for the full term of three years, andd id not coninue their studies further abroad, at once received honourable tpositions.

From the above synopsis it appears that in all these colleges (and I know of no other similar fellowships elsewhere) there are only about twenty-six adequately endowed post-graduate fellowships in science. As these should be continued for at least three years, there is provision altogether for only about nine per year—not one fourth the number required to supply the annual loss in our 150 colleges, to say nothing of the increasing demand through the growth and improvements in the colleges themselves. As it is from such specially trained students that the great professors of the future must be drawn, the need of much greater endowments for new recruits is apparent.

In England the aids afforded by fellowships in their universities are familiar to all. Sir Isaac Newton, who is to modern science what Shakespeare is in literature, was sustained from his student days successively in a scholarship, a fellowship, and as professor at Trinity College at Cambridge. Besides those aids, the Royal Commissioners of the Exhibition of 1851 instituted in 1891 "Exhibition Science scholarships" for advanced students, to which 25,000 dols. yearly is to be applied in sums of 750 dols. each. In the first year sixteen appointments were made, to be held for two, and probably for three, years by students who show capacity, and "who advance science by experimental work." [1]

On this subject a most interesting discussion took place last year in the French Academy of Sciences. On April 27, 1891, the Secretary read the following extracts from the will of the late M. Cahours, a deceased member of the Academy:

"I have frequently had the opportunity of observing, in the course of my scientific career, that many young men distinguished and endowed with real talent for science, found themselves obliged to abandon it, because before beginning they had no efficacious help which provided them with the first necessities of life, and allowed them to devote themselves exclusively to scientific studies.

"With the object of encouraging such young workers, who for want of sufficient resources find themselves powerless to finish works in course of execution, . . . I bequeath to the Academy of Sciences . . . 100,000 francs, . . . the interest to be distributed yearly by way of encouragement to any young men who have made themselves known by some interesting works, and more particularly by chemical researches; . . . as far as possible to young men without fortune, not having salaried offices, and who, from want of a sufficient situation, would find themselves without the possibility of following up their researches. These pecuniary encouragements ought to be given for several years to the same young men, if the Commissioner thinks their productions have sufficient value; . . . to cease when they shall have other sufficiently remunerative positions."

M. Janssen, then addressing the Academy, said:

"This affords an example to all who hereafter may desire to encourage the sciences by their liberality. M. Cahours, who knew the urgent necessities of science, had, like most of us, become convinced of the need of introducing a new form of scientific recompenses.

"Our prizes will always continue to meet a great and noble necessity. Their value, the difficulty of obtaining them, and the *éclat* they take from the illustriousness of the body that grants them, will always make them the highest and most valuable of recompenses. But the value also of the works it is necessary to produce in order to lay claim to them forbids them to beginners. It is a field only accessible to matured talents. But there are many young men endowed with precious aptitudes, inclined to pure science, but turned very often from this envied career by the difficulties of existence, and taking with regret a direction towards more immediate results. And yet many among them possess talents which, if well cultivated, might do honour and good to science. . . . These difficulties are increased every day by the marked advance of the exigencies of life.

"We must find a prompt remedy for this state of things, if we do not wish to see an end of the recruitment of science. This truth is beginning to be generally felt. The Government has already created institutions, scholarships, and encouragements, which partly meet the necessity. Some generous donors are also working in this manner. I will mention specially the noble foundation of Mdlle. Dosne, in accordance with whose instructions a hall is at this moment being built, where young men, having shown distinguished aptitudes for high administration, for the bar, or for history, will receive for three years all the means of carrying on high and peaceful studies. Let us say, then, plainly (and in speaking thus we only feebly echo the words of the most illustrious members of the Academy), that it is by following the way so nobly opened by Cahours that the interests and prospects of science will be most efficaciously served." [2]

Huxley is said to have once stated that "any country would find it to its interest to spend 100,000 dols. in first *finding* a Faraday, and then putting him in a position where he could do

[1] Sir William Thomson, *Proceedings, Royal Society*, 1891, vol. l, p. 225.

[2] NATURE, May 7, 1891 (vol. xliv. p. 17).

the greatest amount of work." It is the post-graduate endowments that must first find and retain to science the Faradays of the future.

A notable instance of the need and value of such aid is found in the recently-appointed head of a great university, who, by such endowments alone, here and abroad, it is said, was enabled to prosecute his studies for ten years successively, reaching thereby the front rank in his chosen department of philosophy.

III.

Another department in great need of pecuniary support is that of the learned and scientific societies. In these England is pre-eminent. Our own societies have endeavoured to follow, as far as they could, their English models. The English societies have rendered to science invaluable service in three main lines:

1. In providing ample means for the publication of scientific papers, showing the progress and the results of their scientific work. In this every society has taken part.

2. In the direct maintenance of original research, in which the Royal Institution has been most conspicuous.

3. In the award of prizes for scientific distinction; but still more important, in the distribution of pecuniary aid, for the prosecution of special scientific researches.

(1) Of these, I regard publication as, perhaps, the most important; not only because it puts the world in possession of what has been done by investigators, but because the very fact that there are means of publication, is one of the greatest incitements to complete and thorough original scientific work.

Of the English societies the Royal Society is the oldest, having been chartered in 1662. It has published 181 volumes of *Transactions* and about 50 volumes of *Proceedings*. For these purposes, in 1881 the expenditure was between 11,000 dols. and 12,000 dols. It has property to the value of about two-thirds of a million of dollars, more than half of which is in trust funds, held for scientific uses. The income on the trust funds in 1891 was about 17,500 dols. (*Proceedings*, 1891, vol. l. p. 235.) In 1828 Dr. Wollaston, in giving it 10,000 dols. in 3 per cent. Consols "to promote scientific researches," charged upon the Society "not to hoard the income parsimoniously, but to expend it liberally for the objects named."

The Royal Institution of Great Britain was founded in 1779, largely through our countryman James Thompson, of Rumford, Vt., afterwards Count Rumford. In 1888 it had property and invested funds for general purposes to the amount of 350.000 dols., and about 40,000 dols. of invested funds for the maintenance of its three professors. In 1887 it expended about 2000 dols. in publications, and it has issued about forty volumes. (*Report*, 1888, p. 13.)

The Linnean Society, now furnished by the Government with permanent accommodation in Burlington House, free of rent, was founded by Sir James E. Smith in 1788, and is devoted to botany and zoology. Its property amounts to about 32,000 dols., but it has no endowed funds for scientific investigation. For some years past its receipts, mainly from contributions, have been about 10,000 dols. a year, of which one-half, about 5000 dols., is spent on its publications, which now number nearly fifty volumes of *Transactions* in quarto, and as many more of its *Journal*. In 1888 7000 dols. were expended in publication. (*Proceedings* [May 4, 1888], 1890, pp. 15, 45.)

Next in order of time is the British Association for the Advancement of Science, founded in 1831. It is sustained chiefly by yearly contributions. Its invested funds amount to about 62,000 dols. Its income and contributions are about 10,000 dols. annually, out of which it appropriates from 6000 dols. to 7000 dols. per annum for the encouragement of scientific investigations, and about 1800 dols. annually for its yearly volume of *Proceedings*. Its publications now number twenty-five volumes. (*Report*, 1891, pp. lxxxvii. to c. 76.)

The Ray Society was founded in 1844. It was named after the Rev. John Ray, who lived from 1628 until 1705. Haller, himself one of the greatest men of science of his time, writing in 1771, in the full light of Linnæus' fame, calls Ray "the greatest botanist within the memory of man." (*Bibliotheca Botanica.*) The society has published about fifty volumes of scientific works of the highest importance. I have not seen any statistics concerning its means or acquisitions; nor have I found any financial report of the scientific societies of Edinburgh or Dublin.

(2) Of these societies, only the Royal Institution directly supports professors for scientific research. It has two laboratories, one chemical and one physical. These were rebuilt in 1872, "in order that original discovery might be more effectively carried on." The society was founded for the declared purpose of "promoting scientific and literary research." It has three professors—one in chemistry, one in physics, and one in physiology. Davy, Faraday, Tyndall, and others who have spent their lives there, have made its annals immortal.

(3) In stimulating research by the appropriation of moneys for specific objects, the Royal Society and the British Association are the chief agencies. Besides some of its own funds, the Royal Society distributes annually £4000, or 20,000 dols., granted by the Government "for the advancement of science." This has been done by applying it to numerous purposes; in 1891, for fifty-seven different scientific objects, in sums ranging from 25 dols. to 3000 dols. each; not confined to natural science alone, but including ethnology and magnetic surveys. Most of the grants were in sums of about 350 dols. or less. (*Proceedings*, 1891, vol. l. p. 242.)

The British Association has disbursed annually for the last forty years from 6000 dols. to 7000 dols. per annum, upon the same system of dividing it up for numerous specific purposes; usually from thirty to forty objects yearly, the grants being in sums ranging from 25 dols. to 1000 dols. The grants are called for and expended for the specific purpose named, and under the direction of some prominent scientific man. Men of science like Sir William Thomson, and others of like renown, have had the administration of many of these grants. These have included for the last six years (save in 1890) the appropriation of 500 dols. per year for a table in the Naples Marine Laboratory. (*Report*, 1890, p. 90.)

We have no single society in this country, save the Smithsonian, that can rival in importance those that I have named in England. And the Smithsonian is not a society, but an institution, established by one man, and he an Englishman. This institution, based upon the bequest of James Smithson, was founded by act of Congress of August 10, 1846. I doubt whether in any country or in any age the bequest of half a million of dollars has ever been followed by such beneficent results, or has ever so profoundly affected the life of science in any country as the Smithsonian Institution has done in America during the last forty-four years of its existence. This has been owing (1) to the wisdom and the profound scientific insight of Prof. Henry, its first secretary and director; and (2) to the corps of able assistants and successors whom his spirit and policy have inspired. Its publications number 26 quarto volumes of "Contributions to Knowledge," 40 volumes of "Miscellaneous Collections," and 44 volumes of "Annual Reports." Its "Contributions to Knowledge" rival, if they do not excel, in rarity and importance, the publications of any other society during the same period. Its expenditure in publications is about 12,500 dols. a year. Under Prof. Henry a good deal was done in research. Under Prof. Langley, the present director, astro-physical research is carried on. Besides the direct scientific work of the Institution, however, its influence has been very great, especially in its relations with the other departments at Washington, and as a medium for the prosecution of other scientific enterprises under authority of Congress. Many of the appropriations of Congress for scientific expeditions for researches in ethnology, palæontology, chemistry, and physics have been due to the presence and co-operation of the Smithsonian Institution. For ethnologic researches alone during the last twelve years, under the administration of the Smithsonian, Congress has appropriated 400,000 dols.; to palæontologic researches within the last three years, 160,000 dols.; to chemical and physical research, 68,000 dols.; and to astro-physical research, 10,000 dols. Besides these, there have been for many years appropriations for maintaining the important investigations of the Coast and Geodetic Survey, and of the Weather Bureau in Meteorology; and for the great scientific work of the Naval Observatory, and of the various scientific divisions of the Agricultural Department and of the Geological Survey. Our Government has been by no means inactive in science.

The principal American scientific associations, omitting those of comparatively recent origin, are the American Philosophical Society of Philadelphia, originally founded in 1744; the American Academy of Arts and Sciences at Boston; the Boston Society of Natural History; the Academy of Natural Sciences; and the Franklin Institute at Philadelphia, the latter founded in 1824 (see *Journal*, vol. i. pp. 71, 129); the New York Academy of Sciences (a continuation of the Lyceum of Natural History); the National Academy of Science at Washington, founded in 1863; and the American Association for the Advancement of Science. Of these, the Philosophical Society has published 29 volumes of its *Transactions;* the American Academy, 26 volumes of *Transactions* and 9 quarto volumes of *Memoirs;* the Boston Society of Natural History, 25 volumes, at a cost of about 600 dols. per year; the Academy of Natural Science of Philadelphia, 48 volumes of *Proceedings* and 12 quarto volumes of its *Journal*, at an average cost of about 1000 dols. per year; the Franklin Institute, 133 volumes of its *Journal;* the New York Academy and its predecessor, about 30 volumes of *Transactions* and *Annals;* the National Academy, 3 quarto volumes of *Memoirs* and some volumes of *Proceedings;* and the American Association for the Advancement of Science, about 40 volumes of *Proceedings*.

The latter society had in 1891 a "Research Fund" of 5254 dols. (*Proceedings*, 1891, p. 441.) None of the other societies, so far as I can find, has any fund specially devoted to research, or makes any specific appropriations therefor. The National Academy and the Academy of Philadelphia have each some funds for their support, and the latter also the Jessup Fund for students in science, on which the income is about 550 dols. yearly. The Philosophical Society from time to time awards the prize established by John Hyacinth de Magellan in 1786—an oval gold plate "for the most useful discovery or invention in navigation or science." One of the earliest awards of this prize was for painting lightning-rods with black lead.

The American Academy of Arts and Sciences awards a gold and silver medal from a bequest of 5000 dols. made to it by Count Rumford, who in 1796 made a similar bequest to the Royal Society. In 1888 this prize was most worthily awarded to Prof Michelson for his researches in light.[1]

The Boston Society of Natural History has a general fund, of which the income is about 6000 dols. It has also a small Walker prize fund and a grand prize fund, from which in 1884 it awarded a grand prize of 1000 dols. to James Hall, of Albany, "for his distinguished services to science." It also administers the expenditure of about 2700 dols. a year for instruction in laboratory work, drawn from the Boston University, and 1500 dols. from the Lowell Fund for the instruction of teachers.[2]

From this comparison of the voluntary associations, it appears that the property, endowed funds, and equipment of the English societies named are nearly tenfold greater than the American, and their publications double; while for direct original research our societies maintain no laboratories and no professors, as is done by the Royal Institution. The English societies distribute yearly from 25,000 dols. to 30,000 dols. for from sixty to seventy-five different scientific purposes, while ours make no such appropriations, simply because they have no funds. To supply this deficiency there is need of large endowments.

The publications of our societies are valuable; the papers have often been of a high character, rivalling those published abroad. But the funds available for publication are insufficient; it is always a question of means. There are a press and surplus of valuable scientific matter, which either is not printed at all, or only gets printed by special subscriptions for the purpose. This ought not to be. After valuable original matter has been produced with great pains and without hope of pecuniary reward, nothing is more discouraging to future research than that even publication can only be had as a charity. This I know, from repeated personal applications, is the condition of things in New York at this moment. It is not creditable that, in a State and country like ours, there should be practically nowhere adequate provision for even the publication of the researches of those who work for nothing but their love of science and its progress. There is very great need of a considerable publication fund, in the hands of some scientific body, through which every valuable contribution to science, not otherwise provided for, might be ensured a speedy publication, after it has been found worthy, as in the practice of the Linnæan Society, first by a critical expert in the particular department, and then by the council of publication.[3]

The stimulus, moreover, to scientific research that would be imparted by the distribution of comparatively small sums, such as are given by the Royal Society and by the British Association, would also be very great; nor is there any reason why the founding of professorships for the express purpose of prosecuting original research in our scientific societies, after the model of the Royal Institution, should not in time be followed by results equally brilliant, and equally beneficial to mankind.

I have endeavoured to point out three main directions in which there is urgent need in this country of pecuniary endowments.

(1) In relief of professors during the transition of the colleges from the schoolmaster system to the university system, whereby all professors in science shall become actively enlisted in the prosecution of original discovery as a part of their duties.

(2) In providing for the future recruits in science, by more endowments for post-graduate study.

(3) By endowments of our scientific associations, both directly to promote original research, and especially also to supply larger means of publication.

It is gratifying to perceive what beginnings have been recently made in response to the needs of science. Only a short time since, in 1885, Mrs. Elizabeth Thompson, of Stamford, Conn., gave 25,000 dols. to a board of trustees of which Dr. Bowditch, of Boston, is president, for the "advancement of scientific research in its broadest sense." The income is annually distributed in sums of from two hundred to five hundred dollars.

Mr. Hodgkins, of Setauket, Long Island, has bequeathed to the Smithsonian Institution 200,000 dols., the income of one-half of which is to be devoted to research into the properties of atmospheric air.

Columbia College has, during the year 1891, received from Mr. Da Costa's estate, before referred to, 100,000 dols. for biology; Harvard, the Joseph Lovering Fund, above stated; 10,000 dols. from Henry Draper for the photography of stellar spectra; the endowments in archæology, above named; and some smaller gifts for various scientific purposes. The University of Chicago and some other institutions have also received important gifts, not to mention those yet to be realised to other colleges from the estate of Mr. Fairweather.

By a bequest of Charles Lenning, the Academy of Sciences of Philadelphia will, in time, receive 20,000 dols.; while half a million of dollars will go to the University of Pennsylvania in aid of instruction in theoretical and practical mechanics, and 200,000 dols. to maintain scholarships. At this University, also, a superb structure for the "Wistar Institute of Anatomy" is now building by General Isaac J. Wistar, at a cost of about 200,000 dols., including endowments designed for original research.[1]

Our reliance in this country must be mainly upon private endowments and the intelligent appreciation of the needs of science. The national Government has done, and is doing, much in certain directions. But aside from the dispositions of legislators, it is restricted by the provisions of the Federal Constitution, and by debated questions of constitutional right. State aid is not thus hampered; but State aid is difficult to obtain, to any adequate degree, on account of the previous habits, prejudices, and political training of the people. No doubt this ought not so to be. The State of New York ought, abstractly considered, to maintain one university of the first class equal in every department to any in the world. But the multiplication of institutions already existing, local jealousies, and aversion to State taxation, make this now probably impracticable.

The remedy is with the people, and through their own voluntary methods. It is the people who have made our Government, its institutions, its methods, and the great aggregate, whatsoever it is, such as we see it to-day. Wealth is rapidly accumulating; much of it in the hands of those who, springing from the people, bear the love of the community in their hearts; and when they and the people at large shall come to see that the cause of scientific advance and the discovery of all new truth are in the deepest sense their cause, responses will, I believe, come to every urgent need; until the work of the people, by its own methods, shall, even in science, be able to confront, without shame, the best work of the monarchies of the Old World.

1 President Lovering's Address, *Proceedings*, vol. xxiv. p. 380.
2 *Proceedings*, vol. xxiv. p. 14
3 President Carruthers, *Proceedings, Lin. Soc.*, May 1890, p. 39.

1 Since the above was written an additional million of dollars has been given by Mr. John D. Rockefeller to the University of Chicago, making 3,600,000 dols. given by him alone to that institution within less than three years, a munificence hitherto unexampled in private endowments, some portions of which, it is hoped, will be available for the maintenance of original scientific research.

SCIENTIFIC SERIALS.

American Journal of Science, December. — Inversion of temperatures in the 26·68 day solar magnetic period, by Frank H. Bigelow. The northern low-pressure and the southern high-pressure belts of North America vary in latitude directly with the solar magnetic intensity, being further north at the maximum and further south at the minimum of the period; whilst the northern high and southern low-pressure belts vary in the opposite manner. This means that an increase of solar magnetic intensity generates the cyclones further south, and causes the anti-cyclones from the polar circulation to travel to the south.—Remarks on colloidal silver, by C. Barus. Colloidal silver possesses properties which can be explained with reference to the analogous behaviour of suspended sediments, allowance being made for differences in the size of particles. The high degree of insulation detected in Carey Lea's metallic mirrors may be interpreted as an instance of the altered behaviour of non-coherent metallic matter.—Resonance analysis of alternating currents, by M. I. Pupin. Part ii. Closed magnetic circuit transformers distort the primary current considerably more than transformers with open magnetic circuits under equal degrees of magnetisation. A ferric self-inductance in circuit with an alternator which gives a simple harmonic E.M.F. distorts the current by introducing higher odd harmonics, principally the harmonic of three times the frequency of the fundamental. Rotary magnetic fields produced by reasonably well-constructed machines are not accompanied by fluctuations in their intensity.—An improved form of interruptor for large induction coils, by F. L. O. Wadsworth. The interruptor consists of a brass wheel about six inches in diameter, with two insulating and two contact segments placed in its circumference, and mounted directly on the shaft of a small electric motor making about 1200 revolutions per minute. Two copper brushes are made to bear on the hub of the wheel and its circumference respectively. The hub and the conducting sectors are in one piece. The insulators are made of slate.

Wiedemann's Annalen der Physik und Chemie, No. 12.—On the measurement of surface tension of water in capillary tubes of different glasses, by P. Volkmann. A good wetting capacity may be insured by soaking the glass tubes in caustic potash, and then washing with distilled water. That the tubes are perfectly wetted is shown by the perfect mobility of the line of contact. The more nearly circular the section of a tube is, the more does the value of the surface tension of water approach 7·38 mg/mm. at 20·2° C., whatever the kind of glass. Tubes of very small diameter give larger values.—On the thermochemical processes in the secondary cell, by Franz Streintz. The following thermochemical equations were derived from the author's experiments:

$$PbO_2 + H_2SO_3\,aq = PbSO_4 + Aq + 767\ K$$
$$PbO_2 + SO_2\ \ gas = PbSO_4 + 844\ K$$
$$PbO_2 + H_2\ gas = PbO + H_2O + 583\ K$$
$$PbO_2 = PbO + O\ gas - 101\ K$$

The E.M.F. resulting from these equations is 1·885 volts. One o the cells worked with, that having the least concentration, gave 1·90 volts.—On the magnetisation of iron and nickel wires by rapid electric oscillations, by Ignaz Klemencic. The strong damping action of magnetisable metals upon electric oscillation is explained by their circular or transverse magnetisation, which crowds the oscillations into the surface layers much more than in the case of other metals. Hence the resistance of a magnetisable wire to electric oscillations is much greater than that of another of equal conductivity. This resistance was determined by studying the development of heat in the wire by means of a thermo couple. The permeabilities of the metals deduced by the formulæ of Lord Rayleigh and Stefan were: Soft iron, 118; steel pianoforte wire, soft 106, hard 115; Bessemer steel, soft 77, hard 74; nickel, 27. These are very near the values found by Baur and Lord Rayleigh for feeble magnetising fields.—Studies of the electric resonator, by P. Drude. The author shows that a Hertzian resonator must be chiefly affected by the electric forces playing at that part of the resonator circuit which lies opposite the gap, and proves this experimentally. The resistance of a Zehnder vacuum tube used in these experiments was incidentally found to be 2870 million ohms when the interruptor made 25 breaks per second.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, December 5.—Capt. H. J. Elwes, President, in the chair.—Mr. F. Merrifield exhibited hybrids belonging to the genus *Saturnia*, obtained by Dr. Standfuss, of Zürich; viz. a male and female hybrid from a male of *Saturnia pavonia* and a female of *Saturnia pyri*, to which he had given the name of *Saturnia emiliæ*; also hybrids from what Dr. Standfuss described as "a male of *Callimorpha dominula*, var. *persona*" (received from Tuscany) and a typical female of *Callimorpha dominula*, to which he had given the name of *romanovi*. Mr. Merrifield remarked that the so-called var. *persona* differed entirely from the type of *Callimorpha dominula*.—Mr. J. W. Tutt exhibited, and read notes on, specimens of a very small form of *Euchloë*, taken in Shropshire by the Rev. F. B. Newnham, who was of opinion that it was distinct from *E. cardamines*. He pointed out that it was much smaller than the latter species, and that the discoidal spot was placed as in *E. turritis* and *E. gruneri* at the juncture of the orange and white spaces, and not, as in *E. cardamines*, well within the orange tip. Mr. Tutt also exhibited, and read notes on, specimens of *Noctua dahlii*, from Cheshire, Essex, Yorkshire, Aberdeenshire, and other counties. The variation in the specimens was said to be partly due to their geographical distribution. Herr Jacoby read a letter received from Mr. Buxton Forman, one of the Assistant Secretaries of the Post Office, to the effect that the Postal Union had decided to make a rule not to allow natural history specimens to be sent by sample post, which was intended for the transmission of *bonâ fide* trade patterns or samples of merchandise, and consequently that the forwarding of such specimens at the sample rate would in future be irregular. Lord Walsingham, F.R.S., stated that he had had a long correspondence with the Post Office authorities on the subject, and that the late Mr. Raikes, when Postmaster-General, promised him in 1891 that such specimens should, so far as the British Post Office was concerned, be transmitted at the sample rates; and a letter to the same effect, from the late Sir Arthur Blackwood, when Secretary of the Post Office, was published in the *Proceedings* of the Society for 1891.—Mr. C. G. Barrett exhibited, for Mr. A. J. Hodges, a specimen of *Hydrilla palustris*, from Wicken Fen, also specimens of *Caradrina ambigua*, from the Isle of Wight. He remarked that one specimen of the latter had the hind margin of the right fore-wing indented, and the wing broadened as though from an injury to the pupa. In this wing the margins of the large orbicular and reniform stigmata had become so joined that the dividing lines had disappeared, and the stigmata were fused into one irregular blotch.—Mr. McLachlan, F.R.S., exhibited, on behalf of Mr. G. F. Wilson, F.R.S., a "grease band" which had been tied round trees to prevent the females of *Cheimatobia brumata* from ascending the trunks for the purposes of oviposition; the band was thickly covered with the bodies of the females, together with a few males.—Surgeon-Captain Manders exhibited a pair of *Chelura bifasciata*, from the Shan States, and called attention to the "assembling" habits of the males, some hundreds of which were attracted by the numerous females which emerged from the cocoons at sunset.—Mr. B. A. Bower exhibited a beautiful variety of *Zygæna lonicerœ*, Esp., having the spots confluent, taken at Chattenden Wood, North Kent, in June last.—Mr. H. Goss exhibited, for Mr. F. W. Urich, of Trinidad, a series of males, females, and workers of *Sericomyrmex opacus*, Mayr., a species of fungus-growing and fungus-eating ant.—Colonel Swinhoe read a paper entitled "A List of the *Lepidoptera* of the Khasia Hills, Part III."—Mr. C. J. Gahan read a paper entitled "On the Longicorn *Coleoptera* of the West India Islands."—Mr. F. W. Urich communicated a paper entitled "Notes on the Fungus Growing and Eating Habit of *Sericomyrmex opacus*, Mayr."—Prof. E. B. Poulton, F.R.S., read a paper, by Prof. E. B. Titchener, entitled "An apparent case of Sexual Preference in a male Insect."—The Rev. H. S. Gorham communicated a paper entitled "Notes on Herr A. Kuwert's Revision der Cleriden-gattung *Omadius*, Lap."

Geological Society, December 5.—Dr. Henry Woodward, F.R.S., President, in the chair.—Supplementary note on the Narborough district (Leicestershire), by Prof. T. G. Bonney, F.R.S.—The tarns of Lakeland, by J. E. Marr, F.R.S. The author had examined several tarns of the English Lake district.

In those cases where the stream issues from the tarn over solid rock, he found either (1) direct evidence that the tarn results from the blocking up of part of a pre-existing valley by drift, causing the deflection of the water to a direction different from that of the original stream in this locality; or (2) evidence which is perfectly consistent with such an explanation of the origin of the tarn. Under the circumstances he submitted that tarns cannot be assumed to lie in rock-basins simply because the issuing stream flows over solid rock (and this assumption has been made), but that those who maintain the existence of such rock-basins must prove the occurrence of solid rock entirely around the tarn.—Description of a new instrument for surveying by the aid of photography, with some observations upon the applicability of the instrument to geological purposes, by J. Bridges Lee. The instrument described in this paper consists essentially of a photographic camera fitted inside with a magnetic needle, which carries a vertical transparent scale divided and numbered to 360°, and also with cross fibres which intersect at right angles. The fittings and adjustments of the instrument are of such a character that the camera can be accurately levelled and directed towards any point in a horizontal direction, and when a photograph is taken in an ordinary way the bearing of the median vertical plane which bisects the instrument through the photographic lens will be recorded automatically on the face of the photograph. The vertical fibre (and its image on the photograph) serves as an index to read the bearing; and the same fibre marks by its shadow a line right across the photograph, which marks the median vertical plane on the image. The horizontal fibre is adjusted to mark on the image the horizontal plane which bisects the photographic lens.—The marble beds of Natal, by David Draper.

Royal Microscopical Society, November 21.—Mr. A. D. Michael, President, in the chair.—Messrs. Swift exhibited and described a microtome, which was made as an improvement on the Cambridge rocking microtome. The chief features were that the razor could be fitted at any angle that might be found best suited to the substance it was desired to cut, that it was possible to cut sections embedded in celloidin in spirit, and that it could be used with the ether-freezing apparatus. Messrs. Swift also exhibited an improved example of their new mechanical stage. The milled heads of the stage were now placed on the same side; the stage had also a greater lateral movement than in the first examples.—Dr. Measures exhibited a new mechanical stage by Messrs. Zeiss. He considered that it would be found to be better protected than the old one, and it would admit a much larger plate. It was also fitted with verniers in both directions reading to $\frac{1}{10}$ of a millimetre.—Dr. W. A. Turner gave a lantern demonstration on recent methods of staining sections of the central nervous system.—Mr. E. M. Nelson described a simple method for measuring the refractive indices of media. He also described a new reflecting camera lucida, and a portable microscope by Zentmayer.

Zoological Society, December 4.—Henry Seebohm, Vice-President, in the chair.—A communication was read from Mr. T. Manners Smith, on some points in the anatomy of the water-mole (*Ornithorhynchus paradoxus*). The paper related chiefly to the muscular anatomy of *Ornithorhynchus*, which was followed by a short description of the trunk-arterial system. As regards the anatomy, Mr. Smith appeared to have worked out for the first time the comparative morphology of the skeletal muscles of the Monotremes as determined by their innervation.—Mr. F. E. Beddard, F.R.S., read a paper upon certain points in the visceral anatomy of *Ornithorhynchus*. The paper dwelt in the first instance with the existence of a free fold passing from the bladder to the liver, where it became continuous with the falciform ligament of the liver. This fold, however, exhibited no traces of an anterior abdominal vein. The author also gave a description of the right auriculo-ventricular valve of the heart. In two hearts examined by him the septal flap of this valve was complete, though less conspicuous than the free flap, owing to the fact that it had either no papillary muscles attached to it, or that the muscles were very small.—Mr. Boulenger read a second report on additions to the Lizard Collection in the Natural History Museum.—Prof. F. Jeffrey Bell called attention to the acquisition by the Natural History Museum of some specimens of remarkable corals of great size from North-west Australia, of which he showed some admirable photographs taken by Mr. Percy Highley. Prof. Bell urged the necessity of the acquisition of large specimens of corals, before coming to any conclusion as to their specific distinctions.

PARIS.

Academy of Sciences, December 10.—M. Lœwy in the chair.—The Secretary announced the death of M. Tchébichef, foreign associate, on December 8.—The decease of M. Ferdinand de Lesseps, on December 7, was referred to by the President, and the meeting adjourned, after receiving the correspondence, as a mark of respect for the deceased member.—A study of the different varieties of graphite, by M. Henri Moissan. Any variety of carbon may be converted into graphite by sufficiently raising the temperature. This graphite may be amorphous or crystalline. Its specific gravity varies from 2·10 to 2·25. Its ignition point in oxygen is about 660°. Its stability, as evidenced by its resistance to transformation into graphitic acid, depends on the temperature to which it has been raised.—A survey made by means of photography, for the delimitation of the frontier between Alaska and British Columbia, by M. Laussedat.—On the secular variations of the orbits of the four interior planets, by Prof. S. Newcomb. (See "Our Astronomical Column.")—On a new ossiferous cavern discovered at Pointe-Pescade, to the west of Alger-Saint-Eugène, by M. A. Pomel. There appears to be no trace of man or of the monkey, though numerous other species of animals are represented in the remains.—On the solution of numerical equations by means of recurrent series, by M. R. Perrin.—On the composition of linear forms and congruences, by M. Stouff.—On elimination, by M. Hadamard.—On the law of resistance of air, by M. C. Chapel. A claim to priority over M. Vallier in regard to the empirical laws recently enunciated by the latter.—An experimental theory of the clipping and punching of metals, by M. Ch. Fremont. A machine is described with which the author has succeeded in registering the work done during punching operations on an indicator diagram.—Integration of the equations of light in transparent and isotropic media, by M. E. Carvallo.—Electromotive force of magnetisation, by M. D. Hurmuzescu.—Determination of the proportions of carbonate of lime and carbonate of magnesia in earths, ashes, &c., by M. Albert Trubert. A description of a simple indirect analysis.—The phosphate of the Grande Connétable, by M. A. Andouard.—On pectase and pectic fermentation, by MM. G. Bertrand and A. Mallèvre. The conclusions have been arrived at, that (1) this ferment is not able to coagulate pectin when acting alone; (2) it produces this transformation only in presence of salts of calcium, barium, or strontium; (3) the precipitate produced is an alkaline-earthy pectate.—On a new process for the purification of alcohols, sugars, and a certain number of other organic matters, by M. E. Maumené.—Influence of radiation at low temperatures on the phenomena of digestion; Frigotherapeutics, by M. Raoul Pictet.—On the morphology and classification of the Coccidians, by M. Alphonse Labbé.—Succession of the lower Tertiary strata in the cretaceous protuberance of Saint-Sever, by M. L. Reyt.—On the *calcaires à lithothamnium* of the valley of the Chellif, by M. Repelin.—Influence of the dryness of the year 1893 on the forest vegetation in Lorraine, by M. Henry. The production of wood for 1893 was but 30 to 76 per cent. of the normal yield.—The ascension of the balloon *Archimède* (October 11, 1894). Comparative thermometric and hygrometric diagrams of the aerostat gas and the surrounding atmosphere, by MM. Gustave Hermite and Georges Besançon.

BERLIN.

Physical Society, November 16.—Prof. von Bezold, President, in the chair.—Prof. H. W. Vogel spoke on the perception of colours, and demonstrated the various effects which monochromatic illumination has on a series of pigments. The effect of two coloured lights on the several pigments was specially interesting. Thus, for instance, red or yellow squares illuminated by yellow and red light appeared to be white and grey; under yellow and blue they appeared to be red, and in yellow and green lights they appeared the same as when illuminated by white light. Dr. Rubens gave an account of experiments carried out on a large scale in conjunction with W. and E. Rathenau on telegraphing to a distance without wires. They were based, in contradistinction to those of Preece, on the principle of the distribution of currents in the conducting earth. On the banks of the Wannsee, near Potsdam, two electrodes were sunk in the water at a distance from each other of 500 metres, and a current from fifty-five accumulators placed on the bank was sent through them. From each of two boats connected by a cable an electrode was immersed in the water, and a telephone inserted into the connection. When the current from the accumulators on the bank was broken, this produced an effect on the telephone audible at a distance of 4·5 kilometres. Small islands lying between the shore and the boats had no influence on the transmission of the signals.

Meteorological Society, November 6.—Prof. Hellmann, President, in the chair.—Dr. Meinardus spoke on sheet-lightning and the various theories in explanation of this phenomenon. He sided with the view that it is due to a thunderstorm of which the lightning is visible, whereas the thunder does not reach the observer owing to total reflection brought about by refraction in the several superimposed layers of air.—Prof. von Danckelman spoke on the climate of Jalu, on the basis of observations made by Dr. Steinbach since the beginning of 1893 with accurate self-registering instruments. Among the peculiarities of the climate, which is continuously and uniformly warm and moist, it is more especially remarkable that thunderstorms and heavy rainstorms occur most usually between 9 and 10 o'clock in the morning. This phenomenon has not as yet been observed anywhere else.

Physiological Society, November 9.—Prof. du Bois Reymond, President, in the chair.—Dr. Levy-Dorn spoke on the effect of various temperatures on the secretion of sweat, and communicated the results of his own experiments on cats, dealing with the secretion of sweat at low temperatures. The sweat glands themselves were kept at the temperature (19°–30° C.) most favourable for the secretion, while the animal's body was cooled by water at 6° C., and secretion was obtained as a result of dyspnœa, notwithstanding the cooling of the body. The same speaker further gave an account of experiments made with a view to testing Prof. Grützner's assertion that heat acts only on centripetal and vasomotor nerves, but does not affect motor or centrifugal nerves. Carefully observing all the experimental conditions described by Grützner, he had found that the action of heat on the sciatic nerve leads to a copious secretion of sweat on the cat's paws, that is to say, stimulates centrifugal nerves.—Prof. Zuntz criticised the objections raised by Bohr and Henriquez against his experiments on the measurement of the work done by the heart, and showed up the errors which had crept into their observations. He next demonstrated the apparatus he had employed for measuring the amount of blood forced out by the heart.

NEW SOUTH WALES.

Linnean Society, October 31.—Prof. Haswell, Vice-President, in the chair.—Notes of a visit to the island of Erromanga, New Hebrides, in May 1894, by Sutherland Sinclair.—Preliminary communications on the cerebral commissures of the mammalia, with special reference to Monotremata and Marsupialia, by G. Elliott Smith. From an examination of the brain in platypus, *Echidna*, *Perameles*, kangaroo, wallaby, kangaroo rat, *Dasyurus* and phalangista, the superior commissure of the cerebrum was shown by the author to be homologous with the psalterium of Placentalia, and not with the corpus callosum. There appears to be no true corpus callosum (as distinct from a psalterium) in any monotreme or marsupial. The hook-like appearance of the hippocampal commissure in sagittal section in marsupials, which led Flower to regard it as corpus callosum, was said to correspond to the shape of the hippocampus, which is co-extensive with the lateral ventricle. In platypus only the dorsal limb of the hook is present, because there is only a rudimentary descending horn of the ventricle and hippocampus. In Eutheria only the ventral limb persists, because the upper and anterior part of the hippocampus disappears to allow a corpus callosum to appear in the situation occupied by the dorsal limb of the hippocampal commissure in Metatheria, *i.e.* ventral to the arcus marginalis. The fascia dentata, as a consequence of this, is essentially *supracollosal*. A doubt was expressed as to the presence of any structure in the submammalia strictly homologous to the Eutherian corpus callosum. The hypothesis was advanced that the latter structure appears (just as the hippocampal commissure does somewhat earlier) to supply the demand for a shorter connecting path for the great pallial development—essentially a mammalian feature.—Descriptions of some new species of Australian Coleoptera, by A. M. Lea. Desciptions were given of forty-nine species from New South Wales, mostly belonging to the *Anthicidæ*. A remarkable *Protopalus* from the Tweed River was described, and a species of *Lagria* living in ants' nests.—Description of a new *Isopogon* from New South Wales, by R. T. Baker. The *Isopogon* described was obtained on the Murrumbo Ranges, Goulburn River. It differs from the N.S.W. *I. anemonifolius* in having deeply-divided leaves on long petioles and a silky hairy perianth; from the West Australian *I. longifolius* in its longer and pinnately divided leaves, smaller cones and longer perianth.—Synonymy of some Australian and Tasmanian mollusca, by John Brazier. The synonymy of twelve species were given with references and habitats.—Further observations upon the anatomy of the integumentary structures in the muzzle of *Ornithorhynchus*, by Prof. J. T. Wilson and C. J. Martin. The authors specially dealt with the details of structure of the "push-rods" in the skin of the snout of the platypus, and offered further confirmation of their views in opposition to a recent criticism of some of these by Prof. E. B. Poulton.—Description of the external characters of a very young specimen of *Ornithorhynchus*, by Prof. J. T. Wilson.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—University Tutorial Series, Vol. 1: A Text-book of Sound: E. Catchpool (Clive).—Manual of Practical Morbid Anatomy: Drs. Rolleston and Kanthack (Cambridge University Press).—The Book of the Rose: Rev. A. Foster-Melliar (Macmillan).—An Elementary Treatise on Theoretical Mechanics, Part 3: Kinetics: Prof. A. Ziwet (Macmillan).—Natural Rights: Prof. D. G. Ritchie (Sonnenschein).—Elementary Qualitative Chemical Analysis: Dr. F. Clowes and J. B. Coleman (Churchill).—Pubblicazioni della Specola Vaticana, Vol. iv. (Torino, Artigianelli).—A Few Chapters in Astronomy: C. Kennedy (Taylor and Francis).

PAMPHLETS.—On the Natural Immunity against Cholera, &c.: C. G. Gümpel (Williams and Norgate).—Elliptical Orbits: H. Larkin (Unwin).—Royal Gardens, Kew, Hand-list of Trees and Shrubs grown in Arboretum, Part 1: Polypetalæ (Eyre and Spottiswoode).

SERIALS.—Engineering Magazine, December (Tucker).—American Journal of Science, December (New Haven).—Strand Magazine, December (Newnes).—Natural History Transactions of Northumberland, &c., Vol. xi. Part 2 (Williams and Norgate).—Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande, &c., Einundfünfzigster Jahrgang, Sechste Folge. L. Jahrgang. Erste Hälfte (Bonn, Cohen).—Medical Magazine, December (Strand).—Le Monde Moderne, January (Paris).—American Naturalist, December (Wesley).—Strand Musical Magazine, No. 1 (Newnes).—Royal Natural History, Part 14 (Warne).

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