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PHYSICAL SCIENCE A HUNDRED YEARS AGO.

Humphry Davy, Poet and Philosopher. By T. E. Thorpe, LL.D., F.R.S. (Century Science Series.) Pp. 240. (London: Cassell and Co., Ltd., 1896.)

THE time is now fast approaching when people will be reckoning up the achievements of the closing century. Undoubtedly the great characteristic of the times in which we and our fathers and grandfathers have lived is the enormously rapid advance which has been made in our knowledge of the earth itself and of the forces of nature. Middle-aged people can remember the time when trains were much less frequent and rapid, the telegraph a rather expensive luxury, and when telephones were not. If they happen to have crossed the ocean in a modern "liner," or have heard of what can be done with modern explosives, or chance to have fallen into the hands of the modern surgeon or physician armed with anæsthetics, antiseptics and hypnotics fresh from the laboratory of the synthetical chemist, they are ready to acknowledge that things are greatly changed since their young days. But it is only after the perusal of such a book as this, that the ordinary reader comes to realise that all these things are not belated inventions which ought to have been given to us sooner, but that the very foundations of all physical science were hardly laid a hundred years ago. If we try to sum up the position in 1796, we find that though some advance had been made in theoretical mechanics and dynamics, there was very little knowledge about heat, light, electricity, or chemistry. It was known, for example, that if sulphur, glass, or sealing-wax was rubbed, or bits of zinc and copper immersed in salt and water, sparks and shocks could be got out of the arrangement, but up to 1800 the phenomena of electrolysis were wholly unknown, and not till even later were the magnetic properties of the current discovered The "corpuscular" theory of light held its own till the early days of the nineteenth century, and "caloric" was still regarded as a sort of matter which could enter into chemical combinations, and could be squeezed out of bodies like water from a sponge. Chemistry at the same time was only just emerging from the disorder attending the dying struggles of the phlogistic doctrine, and even the Lavoisierian system, which had taken its place, was disfigured by many errors which could only be rectified by a long series of experiment more exact than anything which had ever before been possible.

This was broadly the state of physical science when Davy appeared upon the scene. Black and Cavendish were elderly men whose active work was over, and Priestley was ending his days in a distant land. England was at war with France, and there were no chemists of great note in the Germany of that day. This was also long antecedent to the time when chemical and physical laboratories for instruction existed in the universities or elsewhere, and the young Davy owed his introduction to physical science and his opportunities for study, as so many of the past generations of chemists and "natural philosophers" have done, to his association with medicine. Born in Penzance in 1778, he was apprenticed, at the age of seventeen, to an apothecary and surgeon practising in that far western country town where his father's family had been settled since the days of Elizabeth. Here, with no other guide than Lavoisier's "Elements of Chemistry," he set to work, and in the course of little more than a year he had made such progress, and at the same time such a reputation, as to obtain release from his indentures on his appointment as assistant to Dr. Beddoes at the new Pneumatic Institution at Bristol. In less than two years from this time we find him receiving the offer of a post at the Royal Institution in London, then newly started on its career under the influence of Count Rumford.

The story of Davy's rapid progress towards fame is in its main features familiar to the majority of educated Englishmen, but probably few persons have hitherto so completely realised, as will the readers of this book, the poetic element in Davy's character, and the large share it had in determining his choice of associates, as well as the extent to which it appears to account for the quality of some of his scientific work, and the vivacity and ardour with which he pursued his discoveries. Apparently Davy only missed being a writer of poetry in consequence of the attractions of the laboratory, and to speak of him as "poet and philosopher" is to do him no injustice. So early as 1799, soon after his arrival in Bristol, his friend Mrs. Beddoes introduced him to her sister, Maria Edgworth, and to Southey and S. T. Coleridge, with whom the acquaintance ripened into a warm friendship. Not many years later we find him in the company of Scott and Wordsworth in the lake country, and with the former, at any rate, the intimacy was sustained.

Concerning Davy's scientific work, there will perhaps always be some difference of opinion as to the relative merits of his various discoveries. Some may incline to think the isolation of the metals from the alkalis the most important; while others consider the completeness, both experimental and logical, of his inquiry into the nature of oxymuriatic acid (chlorine), which resulted in the establishment of the elemental character of this substance, entitle it to be regarded as his most perfect scientific achievement.

The invention of the safety lamp is, of course, in the popular idea Davy's greatest title to fame; but while undoubtedly the establishment of the principle of its construction represents an important service to science, it seems surprising that he should not himself have introduced some of the, rather obvious, improvements which were made soon after his time by practical men with the object of removing some of the defects of the lamp in its original form, as a protection against the dangers of the mine, and of which Davy must himself have been aware. The claim that was put forward by George Stephenson is discussed fairly in the book, and disposed of justly.

Davy was, of course, much fascinated by the "galvanic phenomena," and it is therefore remarkable that he should have said so little concerning the *arc*, which he was probably the first to observe, and of which he ultimately gave a good description. But there is no

detailed account of this wonderful phenomenon in the successive Bakerian Lectures and other papers, in which he communicated to the Royal Society the results of his numerous experiments with the battery, and only in his "Chemical Philosophy," published in 1812, is it referred to specifically. To us who live so long after, and who enjoy advantages arising directly or indirectly out of Davy's work, it seems strange that the poet, in his nature, did not supply the prophetic insight which was wanting in the philosopher.

The existence of two previous biographies of Davy—the one by Dr. Paris (1831), and the other by his brother John (1840), by no means render this new "Life" superfluous. The book has characteristics and charms of its own which ought to make it popular, and it is to be hoped that the remarkable collection of letters referred to in the preface may wholly or in part find its way into print, as the letters serve to throw an interesting light on the personality of the remarkable man by whom they were written, or to whom they were addressed, as well as on many interesting events of the time.

In reading carefully through the book two statements are to be found, which, as they are matters of fact, ought not to be matters of dispute. The author will forgive us, therefore, for drawing his attention to points in which we believe that he is misinformed.

It is true that Northmore obtained chlorine in a liquid state before this was accomplished by Davy and Faraday; but it was not by "heating the so-called hydrate of chlorine under pressure" (p. 149). Northmore used a brass condensing syringe and pear-shaped glass receivers in his experiments, and there can be no doubt that he liquefied chlorine by mechanical compression (*Nicholson's Journal*, xiii., 1806, p. 234.)

The other is a point of somewhat greater interest. On p. 126 the statement occurs that "Lavoisier never hazarded any conjecture as to the nature of potash and soda." This, however, is apparently irreconcilable with the following passage, which will be found in Lavoisier's "Collected Works," vol. i. p. 119, and which it would seem that Dr. Thorpe must have overlooked or forgotten: "L'analogie pourrait porter à croire que l'azote est un des principes constituants des alkalis en général, et on en a la preuve à l'égard de l'ammoniaque comme je vais l'exposer, mais on n'a, relativement à la potasse et à la soude que de légère présomptions, q'aucune expérience decisive n'a encore confirmées." This passage appears, of course, in Kerr's translation of the "Élémens," and a footnote is there added by the translator to the effect that, from experiments made in Germany, there is reason for supposing that soda is a modification of magnesia, and that the latter seems to be a metallic oxyd. The experiments referred to are obviously inconclusive; but, in discussing them a few pages later, Mr. Kerr makes the statement that these discoveries, if confirmed, "have been in great measure predicted by the conjecture of Mr. Lavoisier, who supposes that those substances which have long been considered as primitive earths are only metallic oxyds combined with oxygen, and that their reduction has hitherto been prevented by the attraction which subsists between them and oxygen being stronger than that between oxygen and carbon."

The translator explains in his "advertisement," at the beginning of the book, that the "new edition of the original having appeared at Paris last winter, expectations were formed that the author might have made considerable improvements; but from a correspondence with Mr. Lavoisier, the translator is enabled to say that the new edition is entirely a transcript from the former. Some very material additions, though not numerous, have been added by the translator in this edition relative to certain discoveries which have been made in some parts of chemistry since the publication of the original." From all this it appears certain that Lavoisier thought at one time that azote was a constituent of potash and soda. He may have changed his mind later, and have communicated his altered views to Mr. Kerr, but he does not seem to have put them upon record in any other way.

W. A. T.

EGYPTIAN MADE EASY.

An Egyptian Reading Book for Beginners: being a Series of Historical, Funereal, Moral, Religious and Mythological Texts printed in Hieroglyphic Characters, together with a Transliteration and a Complete Vocabulary. By E. A. Wallis Budge, Litt.D. (Cantab.), Keeper of the Egyptian and Assyrian Antiquities in the British Museum. Pp. liv + 592. (London: Kegan Paul, Trench, Trübner, and Co., 1896.)

Some Account of the Collection of Egyptian Antiquities in the possession of Lady Meux, of Theobald's Park, Waltham Cross. By E. A. Wallis Budge, Litt.D., &c. Pp. xii + 361. (London: Harrison and Sons, 1896.)

THOSE who remember the profound excitement caused by the appearance of Bunsen's "Egypt's Place in Universal History," and who now take up such a book as Dr. Budge's "Reading Book," will be surprised at the advance the study of Egyptian hieroglyphics has made since that time. Egyptology, in fact, is now on a footing of permanence which its best friends would have despaired of seeing a few years ago, and not only does it rouse the interest of the archæologist and the historian, but the student of folk-lore and of comparative religion, in his search for data, is beginning to lay under contribution its numerous legendary and mythological texts. To such a student a knowledge of the language, however slight, is of great value, as it enables him to control to some extent the translations on which he depends for information, and in many cases to understand the necessary limitations of a rendering into any modern idiom. To attain to even so slight a knowledge has been for many years extremely difficult for the beginner without the aid of a teacher, and only possible after a somewhat heavy initial expenditure in books. Last year, however, it was our duty to call attention to the publication of an extremely serviceable handbook or introduction to the study of the Egyptian language, entitled, "First Steps in Egyptian," by Dr. Wallis Budge, and it is with pleasure that we now note the appearance of a sequel to that volume in the form of a "Reading Book" by the same author, containing a series of complete texts for study. In 1888, Dr. Budge first printed these texts, and, although they appeared without

transliterations and without notes or explanations, they at least supplied the beginner with a good collection of material to work on, though he was still not in a position to walk alone. At the instance of several friends who made use of the book, Dr. Budge has now republished these compositions, breaking the lines up into words, and adding a transliteration at the foot of the page; he has also compiled a complete vocabulary to the texts, giving a number of references to each word, so that it is possible to compare their use in several passages. The student is thus enabled to acquire, without additional help, a knowledge of the language and of the principal literary compositions of ancient Egypt.

The twenty complete texts, which the volume contains, extend over a period from about B.C. 3500 to B.C. 250, and are good specimens of the various forms of composition which occur in Egyptian literature. They comprise fine examples of the biographical texts of the sixth and twelfth dynasties, of the historical inscriptions of the eighteenth and nineteenth dynasties, and of the compositions of the twenty-fourth dynasty, and of the Ptolemaic period, besides religious, moral and funereal texts of various dates. Perhaps the most attractive to the student of folk-lore, however, would be the two pieces with which the book begins—"The tale of the two brothers" and "The possessed Princess of Bekhten." Of these, the former is well known from its striking resemblance in many particulars to the tale of Joseph in Hebrew literature. The latter, however, is not so well known, and may be briefly summarised, as it throws an interesting light on the exceedingly anthropomorphic conception which the ancient Egyptian formed of his gods.

The story runs that the King of Egypt, while receiving homage in Mesopotamia from the neighbouring countries, had seen a beautiful girl, the daughter of the Prince of Bekhten, whom he married and took back with him to Egypt, giving her the title Rā-neferu. Shortly afterwards a messenger came from Bekhten with the news that Rā-neferu's younger sister was sick, and praying that a physician might come and see her. A physician was sent, but he could do no good, as he found the lady was possessed by a devil; so the Prince of Bekhten asked the king to send him a god to cure his daughter. The god Khonsu was accordingly brought with much pomp from Thebes, and arrived at Bekhten after travelling one year and five months. The demon, on beholding Khonsu, at once stated his readiness to go, but asked the god's permission that a feast should first be held to celebrate his departure. The story continues with the following quaint description of the feast of the god and the demon:—

"And the god Khonsu graciously granted this request, and spake to his priest, saying, 'Let the Prince of Bekhten make a great festival in honour of the demon.' Now, while the god Khonsu, who performeth mighty things and wonderful in Thebes, was arranging these things with the demon, the Prince of Bekhten and his army stood by in exceedingly great fear. And the Prince of Bekhten made a great festival in honour of Khonsu, who performeth mighty things and wonderful in Thebes, and they passed a happy day together; and by the command of Khonsu, who performeth mighty things and wonderful in Thebes, that demon departed in peace unto the place which he loved."

The Prince of Bekhten was so delighted that he determined to keep Khonsu in his own country, and he did so for three years, and was only induced to take him back when the god proved to him that his power had departed by appearing to him in a dream as a golden hawk, which came forth from his shrine and flew back to Egypt. This story is a good specimen of Egyptian folk-lore, and illustrates the fact that whatever abstract conceptions of a central and supreme divinity the Egyptian may have entertained, his local gods were extremely human, and endowed with very limited powers.

But if Egyptologists have not been idle in their endeavours to forward the study of the language and literature of the country, private individuals have no less been doing their share by rendering their collections of Egyptian antiquities available for students. In the years 1882 and 1885–6, Lady Meux formed a fine collection of Egyptian antiquities, containing a number of very important objects, which is perhaps, among private collections, second only to that in the possession of the Duke of Northumberland. What the late Dr. Birch did sixteen years ago for the latter collection in his "Catalogue of the Egyptian Antiquities at Alnwick Castle," Dr. Budge has now performed for Lady Meux's collection, in the work the title of which is quoted at the beginning of this review. This catalogue is privately printed, but we understand it has been distributed among scholars and the principal libraries in England and on the continent, so that the contents of the collection are now available for general study. Dr. Budge has made his catalogue as full as possible, translating and giving in full the texts which are painted or inscribed on the more important coffins, stelæ and figures in the collection; while the numerous photographic plates throughout the volume give an excellent idea of the general appearance of the larger objects. The book itself is sumptuously printed and bound, and, dealing as it does with so important a collection, will prove of the greatest value not only to the collector and the antiquary, but to all those who are interested in ethnographical studies, and who concern themselves with the history and remains of ancient religion and ritual.

THE HISTORY OF ELEMENTARY MATHEMATICS.

A History of Elementary Mathematics; with Hints on Methods of Teaching. By Florian Cajori, Ph.D. Pp. viii + 304. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1896.)

THIS unpretentious but trustworthy book deserves a cordial welcome, and is likely to serve a very useful purpose. There is sound sense in the author's conviction that teachers of elementary mathematics may profit greatly by a knowledge of the history of the subject. They are able to arouse the interest of their pupils, in a way which would otherwise be impossible, by telling them something of the course of mathematical discovery, and of the lives of those who have made the science what it is to-day. Even a schoolboy ought to know that Euclid is the name of a man and not that of a book; and an English lad ought surely to associate Newton with something more than the binomial theorem.

Again, the history of mathematics is of direct benefit to the teacher himself in more ways than one. The progress of scientific discovery rarely, if ever, proceeds along strictly logical lines ; and of this fact mathematics affords a conspicuous example. The science took its rise from concrete problems of calculation and measurement : for a long time it remained partly empirical ; and it is only in quite recent times that its axioms and postulates have been submitted to rigorous examination. The significance of this for the teacher lies in the fact that the intellectual growth of the race repeats itself to a large extent in the individual ; thus in teaching the rudiments of algebra and geometry it is by far the best plan to begin with concrete problems and examples, avoiding abstract formulæ, and introducing the appropriate notation gradually, as the necessity arises.

Another wholesome result of this historical knowledge is the lesson of patience which it conveys. A teacher who is vexed and disappointed by the slowness of his class may console himself by reflecting upon the length of time which has been required by mature intellects to obtain a true conception of the nature of fractions, of negative, irrational, and complex quantities, and so on. The controversies to which these subjects gave rise, even among professed mathematicians, are very instructive in throwing light upon the psychological difficulties which every honest student of mathematics must encounter, and which the aid of a sympathetic teacher helps him to overcome.

From all these different points of view the teacher will find Prof. Cajori's book very helpful and suggestive. It is easy to read, without being superficial ; it is composed with a due sense of proportion ; and the limitation of its scope enables the author to enter into sufficient detail without making his work too large. Thus, for example, the account of early printed books on arithmetic and algebra is rendered extremely vivid by the insertion of numerous specimens of notation ; this, more than anything else, enables the reader to appreciate not only the immense advantage of modern notation, but also the extraordinary power of men like Fermat and Tartaglia, who were able, in spite of most imperfect and inconvenient apparatus, to make discoveries of first-rate importance.

Although, perhaps, the sections devoted to the Middle Ages and the Renaissance are the most interesting and profitable, the early pages on number-systems and numerals, and on the Rhind papyrus, are likely to be the most novel to the general reader. For the mathematician it still remains to account for such resolutions as $\frac{2}{43} = \frac{1}{42} + \frac{1}{86} + \frac{1}{129} + \frac{1}{301}$, a list of which occurs in the papyrus referred to. It is difficult to see how they were obtained, or what practical purpose they were intended to serve ; apparently the standard way of representing a fraction was to express it as the sum of aliquot parts with different denominators. It is not merely a question of aliquot parts. Ahnes and his contemporaries must surely have known that $\frac{2}{43} = \frac{1}{43} + \frac{1}{43}$, although even about this it may not be safe to dogmatise.

The most difficult part of a work of this kind is the discussion of modern developments. Thanks to a number of unselfish scholars, the stages of ancient and mediæval discovery have been traced out with great care and precision ; and although much, no doubt, may still be done, the landmarks are familiar, and the data, after all, are limited. But a history of modern mathematics, beginning, say, with the present century, has yet to be written ; and here the amount of material is so vast, and its ramifications so numerous, that to discuss it properly seems to require a trained band of specialists. In dealing with recent times, Prof. Cajori has wisely confined himself to a few points of special interest, such as the progress of trigonometry, the researches on the value and nature of π, the rise of projective geometry, and the discussion of the merits of Euclid's "Elements" as an elementary text-book. He is against the retention of Euclid, but confesses, at the same time, that in his opinion the ideal text-book has not yet appeared. He very properly protests against attempts to prove the postulate about parallels ; and scores a fair hit by pointing out the inconsistency of the conservatives, who swear by Euclid and then ignore his fifth book.

The "Hints on Teaching," referred to in the title, consist of remarks suggested by the historical context, and do not form an integral part of the work. They are the observations of a practical teacher, and commend themselves by their reasonableness and common-sense. Thus, on the one hand, Prof. Cajori recommends that the concrete should precede the abstract, that proofs of the obvious should be avoided, and that in some cases logical rigour should be temporarily sacrificed ; on the other, he insists on the necessity for intelligent teaching, such as will train the mind to independent thought and observation.

For the reader who wishes to pursue the subject further, there are a number of references. It may be suggested that it would be an improvement if the proportion of primary references were larger than it is. Thus, to take an example at random, on page 231 there is an account of Girard's discussion of imaginary roots of equations, and a footnote gives a reference to Cantor II. 718. This is all very well as an acknowledgment on the author's part, but the reader would prefer a reference to the page in Girard where the original passage is to be found. Secondary references of this kind involve waste of energy.

One point to which the author might well have drawn attention is the variety of projective properties of conics to be found in Apollonius. It is certain that Pascal read the "Conics" ; and it is by no means unlikely that modern projective geometry springs from the study of the works of the great geometer of Perga.

A small but rather irritating matter is the inconsistency shown in the transcription of Arabic names. Why, for instance, should we have Al Battânî in two words and Albirûnî in one? And, again, why use the German transcription *dsch* when the English *j* or the international *ǧ* is ready to hand? Thus, on page 110, Abu Ǵa'far al-Ḫázin appears as Abû Dscha 'far Alchâzin, and our old friend 'Omar Khayyám ('Omar al-Ḫajjám) masquerades as 'Omar Alchaijâmi. Let us have either a popular English approximation, or a scientific transliteration ; a German popular version is simply hideous.

We may conclude with a word of praise for the biographical part of the work. So far as the limits of the book allow, the author tells us about the mathematicians

of the past what rightly interests us to know, and what the spirits of the great departed would not resent our knowing. To retail the spiteful gossip that clings to the memory of Kepler or Cardan, and to linger over the details of the Newton-Leibnitz controversy, is not the mark of a generous mind, and is utterly unprofitable besides. We are glad that, in this respect, Prof. Cajori's book is above reproach. G. B. M.

HINDU MEDICINE.

A Short History of Aryan Medical Science. By H. H. Sir Bhagvat Sinh Jee, K.C.I.E., M.D., D.C.L., L.L.D., F.R.C.P.E., Thakore Saheb of Gondal. Pp. 280; with 10 plates. (London: Macmillan and Co., Ltd.)

THE author, an Indian prince, after studying medicine with diligence and distinction in this country, applied himself on his return to India to a study of the ancient medical science of Hindustan. As a result, he presents in this treatise a bird's-eye view of the marvellous civilisation of India, and he does so from the point of view of a Hindu, in a spirit of faith and optimism creditable to his piety and patriotism. Perhaps a larger exercise of the critical faculty might have been more acceptable to Western intelligence, especially as, in some matters of history and chronology, the author is at issue with European authorities; but it might also have spoiled the picture, which is simple and bright. The writer prefaces his account of Indian medical science by a brief sketch of the early civilisation of the Hindus and of their religion, philosophy, science and art. The science and art of medicine were an important feature in this great system, elaborated according to the same principles and by the same methods as other branches of knowledge, and therefore possessing the same merits and the same faults. "The Hindus believe," the author tells us, "that like all their other sciences, the science of medicine has been revealed to them."

The bible of medicine is the "Ayur Veda," whose authorship is attributed to no less a personage than Brahma. Subsequent commentators, chief among them Charaka and Sushruta, have reproduced and somewhat amplified this record. The author, with great insight and judgment, gives an interesting history and epitome of the doctrines and practices laid down in these works, of which he appends a list of 107. We observe that he has not included among these the "Navanitaka," an ancient Sanskrit medical manuscript found by Captain Bower at Kuchar, in Eastern Turkestan, in 1890, and which is believed to be older than the works of Charaka and Sushruta. The development of science by the wise men of the East was a mixture of observation and contemplation. Their observation was keen though somewhat crude, but when the results were submitted to the process of intellectual digestion, an excessive addiction to analysing and systematising produced a code of knowledge into which imagination largely entered, and which was specious and unsound. The product, possessing the character and sanction of a revelation, became straightway a fixed guide, which has remained authoritative and unaltered through the ages. The early medical observers scrutinised closely the structure and functions of the human body, and not content with noting and recording these, they must fully and finally explain them. For this purpose they invented three principles or essences or spirits—*vata*, *pitta*, and *kafa*—wind, bile, and phlegm, which, acting upon and through the constituent parts of the body, gave rise to all the manifold physiological manifestations of the organism. Disease was held to arise from excess, defect, or disorder of one or more of these humours, and the object of the physician in examining the patient, was to detect which humour or humours were at fault, and select the remedy calculated to restrain, stimulate, or correct the aberrant fluid. A doctrine of temperaments was built on the same basis. Associated with these hypothetical spirits, other supernatural agencies were postulated; faults committed in a former state of existence, and the operations of demons, were included among disease causes. It is not surprising, therefore, that rites, ceremonies, amulets, omens, and charms entered largely into treatment. The Thakore Saheb advances strong claims for the antiquity and excellence of Indian medicine. He contends that the medical science of the Greeks, Egyptians, and Arabians, was extensively borrowed from India. He asserts that Jenner and Pasteur were anticipated in the matter of protective inoculation, Morton and Simpson in anæsthesia, Lænnec in auscultation, Piorry in percussion, and Lister in antiseptics by Indian sages; that the vaunted discovery of Harvey was also presaged, if not preceded, by Indian doctrines regarding the circulation of the blood. He shows that modern medicine has derived important practices, such as massage, and many useful drugs, from India, and even goes the length, in apologising for the shortcomings of Indian surgery, of asserting that in ancient times the use of drugs prevented or dispersed tumours, and other conditions now demanding surgical intervention. He expounds at some length the rules of hygiene and disease prevention laid down by the *rishis*. They are mostly personal, and their elaboration is astonishing. Life to the orthodox Hindu was a series of minute rites governing every item of daily existence—some salutary, but most of them frivolous.

Still, with all its absurdities, Indian medicine was a triumph of acumen and industry, and the author has succeeded in placing a very clear and complete compendium of it on record in this book, which he who runs may read. Perhaps his hope that rational and progressive medical science may still be able to learn something from Aryan medical science is a feasible one; but the materials and methods of the latter must to that end be recast in the furnace of modern inductive research.

OUR BOOK SHELF.

On the Adjustment and Testing of Telescopic Objectives. By T. Cooke and Sons. Second edition. Pp. 96. (York: Delittle and Sons, 1896.)

THE first edition of this admirable little volume appeared in the year 1891, and since that time its fame has spread abroad, and both German and Italian translations have been made. In this short interval of time a very notable advance has been made in the construction

of objectives. The new triple photo-visual objective is the outcome of experiments made by Messrs. Cooke's optical manager, Mr. H. Dennis Taylor, in the direction of improving the so-called achromatic telescope. The success with which he has been rewarded, has given astronomers an objective which is not only free from colour aberrations, but which can be used for celestial photography without the necessity of any further adjustment.

In the present edition this new lens is fully referred to, and the communications of Mr. Dennis Taylor to the Royal Astronomical Society are reprinted in full. A supplementary chapter is also added, describing the adjustments of its component parts; this will, no doubt, prove most serviceable to those who are the fortunate possessors of this lens.

In the main, the general text of the book has not been very considerably disturbed; modified views, and the insertion of up-to-date information, have of course required here and there changes in the text, and to some extent enlargement.

Users of telescopes cannot do better than make themselves thoroughly acquainted with the contents of this excellent and valuable source of information. It must be remembered that we are here enabled to make use of the knowledge of those well experienced in the making and testing of numerous objectives, and amateurs and others may gather many a wrinkle, the knowledge and use of which will make all the difference between the bad and good working of an objective with which they are making observations. W. J. S. L.

Fuel and Refractory Materials. By A. Humboldt Sexton. (London: Blackie and Son, 1896.)

THIS book is intended to meet the want of a manual intermediate in size between the exhaustive treatises of Percy, Mills, and Rowan on the one hand, and such brief outlines of the subject as may be found in manuals of metallurgy on the other. Seven chapters out of fifteen are devoted to fuel, one to the recovery of bye-products, three to furnaces and refractory materials, whilst the subjects of pyrometry, calorimetry, utilisation and testing of fuel are dismissed in one chapter each. The book is written in a clear and concise style, and is profusely illustrated with excellent diagrams. The subjects of coking, recovery of bye-products, and preparation and use of gaseous fuel are treated in a very practical manner and in great detail. The chapter on the important subject of pyrometry is not so satisfactory, as although an account is given of almost every type of instrument, whether obsolete or not, the impression is given that the author has little practical knowledge of many of the instruments described, as scarcely any criticism is offered, and the descriptions are often in the inventor's own words. The result is that an engineer, wishing to put in a pyrometer for practical purposes, would receive little assistance in choosing the best type of instrument for any special case. An exact definition of the various thermometric "scales" of the several instruments would also be desirable, so that the exact meaning of a temperature measured, say on the platinum resistance scale, could be clearly shown. The same historic completeness and lack of criticism applies to the chapter on calorimetry; a student might get the idea that for practical purposes it is a matter of indifference whether the heat of combustion of a fuel be determined by Berthier's process (fusion with litharge) or by the Berthelot-Mahler process. Taking the size of the book into consideration, very few essential points have been omitted. It is to be hoped, however, that in the second edition space may be found in Chapter x. for a description of an anemometer of the Fletcher type, the direct measurement of the gaseous velocity in a shaft being much preferable to the indirect methods given. The approximate analysis of flue gases is now so common in works, that a short account of the methods used, together with an application (such as a boiler trial), would be very useful. The only method mentioned for carrying out such analyses is both cumbersome and expensive. At the end of the book is an admirable set of references to works and papers bearing on the subject.

The Lepidoptera of the British Islands; a Descriptive Account of the Families, Genera and Species indigenous to Great Britain and Ireland, their Preparatory States, Habits and Localities. By Charles G. Barrett, F.E.S. Volume III. HETEROCERA: *Bombyces*, *Noctuæ*. Pp. 396. 8vo. (London: L. Reeve and Co., 1896.)

THE present instalment of Mr. Barrett's voluminous work includes the following families: BOMBYCES: *Bombycidæ* [more correctly *Lasiocampidæ*], *Endromidæ*, *Saturnidæ*, *Drepanulidæ*, *Notodontidæ*. NOCTUINA: *Cymatophoridæ*, *Trifidæ* (*Diphthera* to *Agrotis*).

The habits, localities and transformations of the various species are dealt with at considerable length, and practically include most of the available information respecting British *Lepidoptera* likely to be useful to a practical collector. Information respecting the occurrence of British species abroad is likewise furnished in most instances, and reputed British species are also mentioned incidentally.

Entomologists who do not confine their studies to British insects, and who are more interested in classification than in habits, will find Mr. Barrett's remarks on the structure, pattern and classification of that extensive group of moths (the *Noctuæ*) well worth perusal. They form one of the most dominant groups of the larger moths at the present day; but they are very compact, and it is exceedingly difficult to find satisfactory characters by which they can be divided into families. This has been attempted by Guenée, but many writers since his time have abandoned the idea of subdividing the *Noctuæ*, except into genera. Mr. Barrett evidently recognises three main families at least; but we shall be interested to see where he places some of the more aberrant genera usually included in the *Noctuæ*, when he arrives at them in later volumes of his work.

How to Study Wild Flowers. By the Rev. George Henslow, M.A., F.L.S., F.G.S., &c. Pp. 224 (with fifty-seven illustrations). (London: The Religious Tract Society, 1896.)

THIS is a useful little book, and doubtless it will be welcome to many people who live in the country, and who may desire to gain a systematic acquaintance with the flowering plants around them.

We could wish, however, that the author had emphasised the "Floral Formula" part of the business a trifle less, and had given a little more attention to floral diagrams instead. As regards the latter, we might remark that the position of the mother-axis ought always (if possible) to be indicated in the diagrams, otherwise how are his readers to tell which aspect of the flower is posterior and which anterior? A neglect of this necessary adjunct to these figures will tend to render such diagrams as the learner may attempt to construct for himself quite useless, inasmuch as his attention is not directed, as it ought to be, to a definite orientation of the different parts of the flower.

Some of the plants receive a somewhat desultory treatment; but notwithstanding this, and in spite of some errors we have noticed, the book is well worth looking into, on account of the refreshing number of interesting first-hand details which it contains.

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.*]

On a New Law Connecting the Periods of Molecular Vibrations.

IN the current number of NATURE you were good enough to print a short article by me, announcing a discovery which I believed was new. My attention has now been drawn to the fact that it was published a few months ago by Rydberg (*Wied. Ann.*, vol. lviii. p. 674), to whom the honour of the discovery therefore belongs. My excuse for being unacquainted with Rydberg's paper must be found in a prolonged absence from home last summer, and the large amount of unread scientific literature which I consequently found on my return home. There is, moreover, nothing in the title of Rydberg's paper which would indicate the important nature of its contents. If by writing to you on the subject I have drawn the attention of physicists to what I consider the most important fact yet brought to light concerning molecular vibrations, my article will have served some good purpose. ARTHUR SCHUSTER.

The Athenæum, Pall Mall, S.W., January 2.

The Pound as a Force.

A VERY few words are necessary from me in answer to Prof. Perry's letter on page 177. First and foremost (though referring to the latter part of his letter, not to the cow and bridge portion), if any sentence in my previous communication can have led any one to imagine that I consider Prof. Perry anything but a most admirable teacher of his own subject, that sentence must have been villainously expressed. Secondly, when I said that engineers had mostly to deal in their calculations with bodies either at rest or in uniform motion, I thought I was speaking in the sense of Prof. Perry's original article (he said the same thing himself near the top of column 1, page 50), and that I should have his concurrence: I would not for a moment argue such a point with him. If I had thought it necessary to be cautious I would have used the word "suggest" instead of the word "tell" in my sentence about acceleration: to the idea in which however I still respectfully adhere. And in general I adhere to all the *matter* of my last communication, though with full deference to his criticism on the *manner* of it. Thirdly, I cannot remember that I have ever specially "advocated" the poundal. I have never much liked it, but it is useful as a stepping-stone to higher things, in a way that the familiar pound-weight is not. Fourthly, I agree with Fitzgerald that Newton's second law furnishes by no means the only measure for quantity of matter (chemical equivalence also furnishes a measure), but inertia is the fundamental property and measure for dynamical purposes. Fifthly, we do not "assume" that inertia is proportional to weight; we verify it within certain limits of error by dropping bodies (like Galileo), or (like Newton) within narrower limits by swinging pendulums: essentially the same process. Sixthly, I do not, alas, find it at all easy to give full marks to a student for his answer to such a question as "What is Ohm's law?"; and, although I cannot plead guilty to the accusation of having spoke disrespectfully either of Gravity or of Engineers, I do find that occasionally the treatment of the former by the latter leaves something to be desired in point of clearness; the occasional educational remarks of the periodical called *The Engineer*, for instance, seem fairly representative of a large and influential class. And lastly, although a remark immediately following his citation of a familiar electrical equation leads me to think that Prof. Perry still misses the chief point of my letter, yet there are quantities of things in the present correspondence on which we agree; and chief among them is the profound conviction we share that there is a crying need for reform in our whole system of secondary education. OLIVER J. LODGE.

Liverpool, December 27, 1896.

The Theory of Dissociation into Ions.

THE numerical agreement obtained when certain properties of solutions are interpreted on the theories of osmotic pressure and ionic dissociation is undoubtedly very striking, and it is, consequently, not very surprising that these theories have obtained such a ready acceptance. Whatever may be our opinions as to the validity of the theories, and even of the harm which has been done by pressing them too far, we cannot but recognise that they have been the origin of much good work on a condition of matter which is, at the same time, one of the most obscure and one of the most important, both from the physicist's and chemist's point of view. But, however convenient such theories may be as working hypotheses, their advocates should not have forgotten that they depend solely on the numerical relations alluded to, and that something more than this is required before such hypotheses can be raised to the level of acceptable theories, and far more before they should be held up as an indispensable article of faith, which unless a chemist believe he cannot be saved.

For a theory to be acceptable it should, at the very least, be reasonably probable, and should not violate any fundamental and well-established facts; it should stand the test of any apparently crucial experiments brought forward to settle between it and its rivals, and, I think we may add, it should give some explanation, not simply of the behaviour of matter in the condition in question, but also of why matter ever assumes such a condition.

The theories of osmotic pressure and ionic dissociation, I believe, have not done this. Even if we can accept as probable the view that atoms united so firmly together, as we have every reason to believe are those of, say, chlorine and hydrogen, will fly affrighted from each other at the mere approach of a few water molecules, which are represented as being more or less inert and destitute of any strong attraction for the dissociated atoms; even if we can imagine that these atoms, so strongly charged with electricity of opposite signs, can meander about in the liquid, with a supreme disdain for their former associates and the attractive charges which they carry; even if we can reconcile this indifference with the behaviour of these very atoms to a similar electric charge on other similar companionable atoms, when these latter happen to be agglomerated into the form of an electrode; even if we find no difficulties in all this, still we must admit that the theories in question afford no explanation whatever why a substance should dissolve at all, and they can, therefore, hardly be accepted as a sufficient explanation of solutions. We cannot treat Nernst's statement that a substance goes into solution because it has a "solution pressure" seriously, and, in cases where the dissolved substance is known to form hydrates, the view that an excess of water will decompose these hydrates, and free the substance entirely from its union with water, without the formation of any other compounds, is quite opposed to our knowledge of the action of mass in chemical changes.

Nor can we ignore the thermal difficulties in which the theory of dissociation lands us; for if, to satisfy the facts of the case, we admit that dissociation is accompanied by a large evolution of heat, we must suppose, either, that the evolution which accompanies the reverse action when the water is absent (*e.g.* $H_2 + Cl_2 = 2HCl$, gases), is due to heat being evolved by the dissociation of molecules of elements into their atoms, or, as has been asserted, that the atoms of the dissolving electrolyte evolve heat by combining with their electric charges, a novel method of evolving heat, which should long ago have made the fortunes of the discoverers, especially as the charges with which the atoms combine come into existence of their own accord, and without the expenditure of any external energy.

Turning to the "crucial" experiments suggested, we do not find the results to be any more satisfactory from the point of view of the theory. We have on the one side two experiments heralded in by Prof. Ostwald with great flourish of trumpets; the "imaginary" experiment already quoted by Dr. Herroun, in which an ultra-microscopical trace of liquid is electrolysed by an electrostatic discharge, and the "arm-chair" experiment of "chemical action at a distance," the results of both of which might have been predicted, as I have shown elsewhere, by any one possessing an elementary knowledge of electricity, long before the dissociation theory was dreamt of.

On the other side we have two experiments, which would seem to be conclusive, but which the dissociationists have hitherto thought fit to ignore.

Osmotic pressure, they hold, is due to the quasi-gaseous pressure of the solvent and dissolved substance acting on a diaphragm, which, being permeable to the solvent only, renders the pressure of the dissolved substance inoperative, and hence

causes the total operative pressure of the solution to be that of only the solvent present in it. Now, I have shown that if we take a solution such as that of propyl alcohol in water, and place it in a semipermeable vessel surrounded by water, the latter will pass through towards the solution, *ergo*, the vessel is permeable to water but impermeable to the alcohol; but if the same vessel with its same contents is surrounded by propyl alcohol, it is the alcohol that passes through towards the solution, *ergo*, the vessel is permeable to the alcohol, but not to the water, and must, therefore, at the same time, be both permeable and impermeable to each substance; which is absurd. The obvious conclusion to draw from this experiment is, that it is the solution, and not either of the substances separately, to which the membrane is impermeable, and this is just what we should anticipate on the hydrate theory, the molecules of hydrates being necessarily larger than those of their constituents.

As to ionic dissociation: When one molecule of sulphuric acid is added to 100 molecules of water, if no change occurs, we shall have a total of 101 molecules, entities or acting units, whatever they may be called; if hydrates are formed, we shall have less than 101 acting units; and if dissociation occurs, we shall have more than 101. Relying on the depression of the freezing-point, the dissociationists maintain that this last is the case, and that something between 101 and 103 acting units are present; but, if this method is really to be trusted, it proves too much, for by measuring the depression of the freezing-point of a large bulk of acetic acid produced by adding to it bodily the $100H_2O + H_2SO_4$, we find that this mixture contains very considerably less than 100 acting units, instead of more.

The explicit evidence afforded by such experiments surely calls for some comment on the part of those whose theories seem to be negatived by it, and their silence on the subject is so significant that it is surprising that it should not have attracted more attention than it has.

The strong evidence of the existence of compounds such as hydrates in solutions, both concentrated and weak, is inconsistent with that perfect freedom of molecules and atoms postulated by the dissociationists, but the discussion of this evidence cannot be attempted here.

The hydrate theory did not lead, and probably never would have led to an explanation of that peculiar behaviour of electrolytes which simulates dissociation, but, as I showed some years ago (*Ber. deutsch. chem. Gesell.*, and, in outline, in an article on Solutions in "Watts' Chemical Dictionary"), the theory is perfectly consistent with the observed facts, and, further, affords an explanation of them, which is free from the serious objections attaching to the dissociation theory.

Bath, December 23, 1896. SPENCER PICKERING.

Some Neural Descriptive Terms.

IN a recent circular asking the opinion of experts as to the prevailing and preferred usage of anatomic and neurologic terms, on behalf of the projected Dictionary of Philosophy and Psychology, Dr. C. L. Herrick mentions certain terms and principles which have been either proposed or adopted by me.

But for the request to "respond as early as possible," I should suggest that replies be either delayed or regarded as provisional until after the appearance of my paper, "Neural Terms, International and National" (*Journal of Comparative Neurology*, vi. pp. 216-340, December 1896), wherein the general subject is discussed at length, and in parallel columns are given the neuronyms adopted by the Anatomische Gesellschaft in 1895, and those now preferred by me. But for the remoteness of Dr. Herrick's present address the following comments would be submitted to him first.

3 (*b*). For the part now called by the Gesellschaft "Substantia perforata lateralis," I formerly proposed *præperforata*, but since 1889 have employed *præcribrum*.

4 (*e*). *Metencephalon*, as employed in the last three editions of "Quain," and adopted by me in 1881, designates the last definitive encephalic segment, *i.e.* between the cerebellar segment (our epencephalon) and the myelon or spinal cord. As given in the circular, it has two other usages, viz. either for the cerebellar segment alone (His), or for both regions (some authors). The encephalic segments will form the subject of a paper at the coming meeting of the Association of American Anatomists.

(*g*). *Metencœle* is doubtless a misprint for *metacœle*. The Latin (international) forms are *metacœlia* and *mesocœlia*; the national English forms *metacele* and *mesocele*.

(*j*). As to *Neuron* (proposed by me in 1884 as a mononym for *axis cerebro-spinalis*) see "Reference Handbook," ix. 100, and *Proceedings Assoc. Amer. Anat.*, 1895, 44-45. Indirect endorsement of it is contained in such compounds as *neuromere*, *neurenteric*, &c. In like manner *myelencephalon* (for either the entire cerebro-spinal axis or for the last encephalic segment) embodies indirect endorsement of *myelon* for *medulla spinalis*.

As to *cephalic* and *caudal*, *cephalad* and *caudad*, during an experience of sixteen years no actual instance of misapprehension has been observed. But since they evidently are not acceptable to some, might not the increasing employment of *præ* and *post* in composition with the force of adjectives justify taking these prepositions as the bases of adjectives, viz. *præalis*, *postalis*; Eng., *præal* and *postal*; adverbs, *præad* and *postad*? As mere vocables the last two are no more objectionable than *quoad*.

Classic precedents for the derivation of adjectives from prepositions or adverbs are *contrarius*, *extraneus*, *proprius*, *crastinus*, *pristinus*, *interior*, *supernus*, and ἀνώτερος.

Ithaca, N.Y., December 19, 1896. BURT G. WILDER.

Measurement of Crabs.

IN his letter of December 3, Mr. Cunningham suggests that if the young crabs be compared so that the frontal ratio is taken as the standard of comparison between the respective groups of the two years, the difference will be one of carapace length only, and this may be due to variation in the food supply. But he does not explain why the effect of the supposed variation in the food supply should be confined to the one dimension of carapace length, and not extend to the frontal ratio also. There is no evidence to lead us to suppose that the change of frontal ratio is a more accurate criterion of development than carapace length; but whichever be taken as a basis for comparison, the result is a change of shape in the carapace as between the two years.

I have, however, to make a correction as to the *adults*, two groups of which, belonging to different years, I compared in my paper as being equal and comparable. I had reason for thinking that they were equal; but I regret to say that a more accurate investigation of them, to which I was led by Mr. Cunningham's criticisms, shows me that they were not so, and that the inequality was not a natural one, but was due to an unconscious selection in the process of collecting them; and therefore these two groups are not comparable, and must be eliminated from a consideration of the question.

December 28, 1896. H. THOMPSON.

Marriage of the Dead.

MARCO POLO narrates of the Tartar tribes thus:—"They have another notable custom, which is this. If any man have a daughter who dies before marriage, and another man have had a son also die before marriage, the parents of the two arrange a grand wedding between the dead lad and lass. And marry them they do, making a regular contract! And when the contract papers are made out they put them in the fire in order that the parties in the other world may know the fact, and so look on each other as man and wife. And the parents thenceforward consider themselves sib to each other just as if their children had lived and married. Whatever may be agreed on between the parties as dowry, those who have to pay it cause to be painted on pieces of paper, and then put these in the fire, saying that in that way the dead person will get all the real articles in the other world" (Yule, "Book of Ser Marco Polo," 2nd ed., vol. i. pp. 259-260). On this narration of Polo, the late Colonel Yule, quoting the authors of later date, remarks that "this is a Chinese custom, though no doubt we may trust Marco for its being a Tartar one also" (p. 260).

As it is not well known whether or not there is a record of this strange custom earlier than the beginning of the dynasty of Yuen, I was in doubt whether it was originally common to the Chinese and Tartars until I lately came across the following passage in "Tsoh-mung-luh" (Brit. Mus. copy, 15297, *a* 1, fol. 11-12), which would seem to decide the question—"In the North there is this custom. When a youth and a girl of marriageable ages die before marriage, their families appoint a match-maker to negotiate their nuptials, whom they call 'Kwei-mei' (*i.e.* 'Match-maker of Ghosts'). Either family hands

over to another a paper noticing all pre-requisites concerning the affair; and by names of the parents of the intended couple asks a man to pray and divine; and if the presage tells that the union is a lucky one, clothes and ornaments are made for the deceased pair. Now the match-maker goes to the burying-ground of the bridegroom and, offering wine and fruits, requests the pair to marry. There two seats are prepared on adjoining positions, either of which having behind it a small banner more than a foot long. Before the ceremony is consecrated by libation, the two banners remain hanging perpendicularly and still; but when the libation is sprinkled and the deceased couple are requested to marry, the banners commence to gradually approach till they touch one another, which shows that they are both glad of the wedlock. However, when one of them dislikes another, it would happen that the banner representing the unwilling party does not move to approach the other banner. In case the couple should die too young to understand the matter, a dead man is appointed as a tutor to the male defunct, and some effigies are made to serve as the instructress and maids to the female defunct.[1] The dead tutor thus nominated is informed of his appointment by a paper offered to him, on which are inscribed his name and age. After the consummation of the marriage the new consorts appear in dreams to their respective parents-in-law. Should this custom be discarded, the unhappy defuncts might do mischief to their negligent relatives. . . . On every occasion of these nuptials both families give some presents to the match-maker ('Kwei-mei'), whose sole business is annually to inspect the newly-deceased couples around his village, and to arrange their weddings to earn his livelihood."

This passage is very interesting, for, besides giving us a faithful account of the particulars, which nowadays we fail to find elsewhere, it bears testimony to the Tartar, and not Chinese, origin of this practice. The author, Kang Yu-chi, describes himself to have visited his old home in Northern China shortly after its subjugation by the Kin Tartars in 1126 A.D.; so there is no doubt that among many institutional novelties then introduced to China by the northern invaders, Marriage of the Dead was so striking that the author did not hesitate to describe it for the first time.

According to a Persian writer, after whom Pétis de Lacroix writes, this custom was adopted by Jenghiz Kân as a means to preserve amity amongst his subjects, it forming the subject of Article XIX. of his Yasa promulgated in 1205 A.D. The same writer adds:—"This custom is still in use amongst the Tartars at this day, but superstition has added more circumstances to it: they throw the contract of marriage into the fire after having drawn some figures on it to represent the persons pretended to be so marry'd, and some forms of beasts; and are persuaded that all this is carried by the smoke to their children, who thereupon marry in the other world" (Pétis de Lacroix, "History of Genghizcan the Great," trans. P. Aubin, London, 1722, p. 86). As the Chinese author does not speak of the burning of papers in this connection, whereas the Persian writer speaks definitely of its having been added later, it seems that the marriage of the dead had been originally a Tartar custom, with which the well-known Chinese paper-burning was amalgamated subsequently between the reigns of Genghiz and his grandson Kublai—under the latter Marco witnessed the customs already mingled, still, perhaps, mainly prevailing amongst the Tartar descendants. KUMAGUSU MINAKATA.

The Heating of Anodes in X-Ray Tubes.

IN reply to Mr. Walter Chamberlain's inquiry (p. 198), it must be borne in mind that spark length is not *per se* a criterion of the energy delivered to a vacuum tube. The length of spark is more or less proportionate to the maximum E.M.F. of the discharge, while the energy of a discharge depends upon the nature of the curves of both E.M.F. and current, and may bear but a small relation to the maximum E.M.F. Large coils which have secondary wire of considerable section and comparatively large electrostatic capacity, give a much greater electric quantity and, consequently, much more energy for each discharge, even when worked so as to give only short sparks, than do smaller coils the secondary wire of which is of smaller section and capacity.

Röntgen-ray tubes should be excited during exhaustion with a coil of the same dimensions as the one that they are ultimately destined to be worked with. This is a point which does not seem to receive sufficient attention from commercial tube manufacturers. A. A. C. SWINTON.

66 Victoria Street, London, S.W., January 1.

Sesamoid Bones.

JUDGING from a small collection of X-ray photographs made during the year, the female hand seems better provided with sesamoid bones than the male.

In my prints, in the female hand a sesamoid is most often found in the metacarpo-phalangeal joint of the little finger, less frequently in the index: in one case there are two in the inter-phalangeal joint of the thumb; in this hand, including the two always found in the metacarpo-phalangeal joint of the thumb, there are no less than six sesamoids. In male hands the bones seem to be more evenly divided between the index and fifth fingers. In most cases the sesamoids are larger in the female hand. F. J. REID.

December 26, 1896.

Discharge of Electricity by Phosphorus.

THE discharging power for electricity of slowly oxidising phosphorus appears to have been known for much longer than Messrs. Elster and Geitel (see p. 155) seem to be aware of.

In the 1855 edition of the "Encyclopædia Britannica," vol. viii. p. 622, an apparatus is described for collecting atmospheric electricity, first used by Matteucci, in which a piece of phosphorus projecting from a glass tube is connected to an electrometer by a long wire, and exposed to the air whose electrical state is to be investigated. It is said to have been found very useful for this purpose. J. R. ASHWORTH.

Rochdale, December 26, 1896.

Shooting-stars observed on January 2.

THIS morning, between six and seven o'clock, there has been a very unusual number of shooting-stars. The radiant point was somewhere near Corona. I saw, on the whole, two or three dozen. The brightest was not much inferior to Jupiter.

Sheffield, January 2. H. C. SORBY.

THE GEODETIC SURVEY OF SOUTH AFRICA.[1]

THE Report on the Geodetic Survey of South Africa, presented to both Houses of the Cape Parliament, and printed in Blue-book form, is interesting and important. It is a record of geodetic work well planned and ably carried out, and it has a permanent value, not only from a scientific point of view, but as an accurate basis upon which all future surveys of the country may be confidently founded.

Soon after his appointment as H.M.'s Astronomer at the Cape in 1879, Dr. Gill recommended that a geodetic survey should be commenced, and formulated a scheme "for a gridiron system of chains of principal triangulation extending over the Cape Colony, the Orange Free State, Natal, and the Transvaal." His recommendations were cordially supported by Sir Bartle Frere and Sir George Colley, then respectively Governors of the Cape Colony and Natal; but it was not until June 1883 that the work was fairly commenced, by the measurement of a base-line in Natal. On the completion of this operation, severe pressure was applied by the Government of Natal to accelerate the work at the expense of accuracy; and on two subsequent occasions the question of suspending the survey was seriously considered. It was no easy task to convince Governors and Ministers that true economy lay in "basing all future surveys upon a principal triangulation of such accuracy, that its results might be

[1] The last clause in original text is doubtful in reading. Perhaps it will be more correct to render it: "And the family of the intended bride provides her with various sorts of utensils and apparel needful to her nurse and maid-servants in the other world."

[1] "Report on the Geodetic Survey of South Africa." Executed by Lieut.-Colonel Morris, R.E., C.M.G., under the direction of David Gill, H.M.'s Astronomer at the Cape. Parliamentary Paper. Pp. xii + 291. (Cape Town: Richards, 1896.)

considered definitive for all future time"; but Dr. Gill succeeded. By a happy combination of tact and firmness he was able to resist all attempts to lower the standard of survey, and, in the face of grudging support, to carry out a considerable portion of his original scheme. Maclear's arc has still to be extended to Port Nolloth, and this extension to be connected with Mr. Bosman's excellent triangulation in Bechuanaland; the eastern end of the latter triangulation has to be connected with the geodetic triangles near Kimberley, and Kimberley, through the Orange Free State, with the Natal triangulation. When these operations have been completed, let us hope in a not far distant future, they will yield an arc of 14° of longitude.

Dr. Gill's success thus far leads him to look forward and ask whether the progress made in geodetic survey in South Africa might not be regarded as the first step in a chain of triangulation which shall extend continuously to the mouth of the Nile. Further he would, by an additional chain of triangles along the coast of the Levant, and through the islands of Greece, connect the African and Greek triangulations, and so, with Struve's great arc of meridian, measure an arc of meridian 105° in amplitude. Even though the completion of a work of such magnitude cannot be expected for many years to come, Dr. Gill has done good service by pointing out the mode of procedure that might be adopted, and the desirability of at once undertaking the definite survey of Egypt. Proposals for such a survey were made soon after the British occupation, but, for financial reasons, which would probably be still urged, they were not entertained. We trust, however, that the commencement of a work of such economic value to Egypt, and of such geodetic importance, will not be much longer delayed.

Dr. Gill was most fortunate in the officer selected to take charge of the field operations. Captain (now Lieut.-Colonel) Morris, R.E., C.M.G., made, personally, nearly the whole of the astronomical observations, and of the measurements of the angles of the triangulation, as well as the greater part of the computations. He also arranged for the transport of the delicate instruments over much rough country, managed distant heliostat parties, looked after men, horses and cattle, and, with much tact, persuaded the farmers to allow beacons and observatories to be erected on their lands. When it is remembered that the 18-inch theodolite with its stand weighed 1042 lbs., and that it was packed in five boxes, of which that containing the body of the instrument weighed 400 lbs., the transport difficulties are apparent. The able manner in which Colonel Morris carried out his duties may be gathered from his Report, which fills a large portion of the Blue-book, and the fact that no breakdown occurred at any time throughout the work. As Dr. Gill well says: "Colonel Morris' services have been such as very few men have the combined physique and capacity to render."

The survey was carried out with great care and accuracy with the improved instruments of the present day, and it takes a high place amongst the geodetic surveys of the world. The standard of measure was the Cape 10-foot standard Bar A., the length of which, in terms of the international mètre, was determined at Breteuil by M. Benoit, then Chief Assistant of the International Bureau of Weights and Measures. The constants of two Tonnelot thermometers, for employment in the comparison of the base-apparatus with the standard, were also investigated at Breteuil under the direction of Dr. Brock. The base-measuring apparatus, made by Troughton and Simms, consisted of five 10-foot steel bars, "so mounted as to be conveniently handled and aligned, and provided with means for determining the instantaneous temperature of each bar." The steel bars were compared with the standard by means of an instrument, the Comparateur, designed by Dr. Gill, of which a full description, with plates, is given.

Three base-lines were measured, each by a different method. The Natal base was measured throughout its whole length, 10,800·45 feet. The line was divided into three sections of about 3600 feet, and each section was measured backwards and forwards in successive horizontal 50-foot lengths. The verification of the base showed a close agreement (a difference of ·0002 feet in the one case, and of ·0027 feet in the other) between the two outer sections as derived, respectively, by direct measurement, and by triangulation from the central section. As this appeared to show that accuracy could be obtained without the measurement of long base-lines, it was decided in the case of the Port Elizabeth base to measure only about 5600 feet, and afterwards to prolong it both ways to a total length of 17,058·49 feet. The measured base was divided into eight sections of 700 feet, each of which was measured forward in ascending, and backward in descending temperatures, and the measurements were, as far as possible, completed the same day. In the Kimberley base 6000 feet were measured, and the prolongation to 14,760·3 feet was all in one direction. Here the measured base was divided into twelve sections, so as to ensure the completion of the forward and backward measurements in the same day. The probable errors in the lengths of the three bases are: Natal ± 0·140 inches; Port Elizabeth ± 0·072 inches; Kimberley ± 0·081 inches. The probable error of the Zwaartland base, measured by Maclear with the Colby compensating apparatus used for the measurement of the Lough Foyle base, is ± 2·362 inches.

For the triangulation two instruments were used: an 18-inch theodolite by Troughton and Simms, and a 10-inch theodolite by Repsold of Hamburg. The larger theodolite, though an admirable instrument, was inconvenient from its great weight and bulk; and, in spite of every care, the pivots, being made of comparatively soft material, became slightly deformed by wear. The Repsold theodolite was much more portable than the 18-inch, being less than a quarter its weight; it had hardened steel pivots which stood seven years' hard service, and it could be used both as a transit instrument and as a zenith telescope. It was consequently exclusively used, after its introduction, for astronomical observations, and the measurement of horizontal angles; and it seems to be an excellent instrument for geodetic work in a country where difficulties of transport may be expected. The probable error of an observed angle with the 18-inch is ± 0″·49, and with the 10-inch ± 0″·33. These results, especially the latter, compare well with those of the best geodetic surveys of other countries. Those obtained with the Repsold are only inferior to the results of the survey of Saxony (± 0″·23), and of the U.S. Coast Survey—San Francisco and Salt Lake series (± 0″·25). The interesting table of probable errors of measurement of a single angle in the best surveys given by Dr. Gill, shows how far the Ordnance Survey (probable error ± 1″·19) has been left behind by more recent surveys, and how desirable it is, from a scientific point of view and in the interests of geodesy, that the angles of the principal triangulation should be remeasured with the more perfect instruments of the present day.

The measured bases of the South African survey were connected by chains of triangles; and other stations, including those of Maclear's survey, were adjusted to the system of the geodetic circuit. A good account of the circuit solution is given by Colonel Morris in his Report. The observations of vertical angles were generally taken in the afternoon, when the effects of vertical refraction were most uniform, and the heights were adjusted on the same principle as the horizontal angles. The results were satisfactory. The difference between the levelled height of Zwaartkop Mountain

station, and the height, determined by computation, through a chain of triangles over 400 miles long, from Buffelsfontein station, the height of which was determined by levelling operations at Port Elizabeth, was only 1·6 feet.

Most of the astronomical observations were made with the Repsold theodolite, but before its arrival the latitudes were determined by a Talcott zenith telescope, constructed by Troughton and Simms. As regards latitudes the preliminary results only are given, for since the observations were made the whole of the stars have been reobserved on the meridian with the Cape transit circle. The origin of all the longitudes is the centre of the transit circle, and all the results depend upon signals exchanged with the Cape Observatory. The longitude of Durban was determined as part of the work in the telegraphic connection of the longitudes of Aden and the Cape; and observations of longitude were made at other places, as circumstances admitted, by Colonel Morris, Mr. Maclear, and Mr. Pett. Astronomical observations of azimuth were made at several of the principal stations, and the observed azimuths were referred to lines of the principal triangulation.

The survey, on the whole, appears to give results slightly in favour of Airy's elements of the earth as compared with Clarke's, but, as Dr. Gill remarks, this conclusion must be adopted with great reserve. For final results we must await the completion of Dr. Gill's original scheme.

Colonel Morris' Report contains a statement of the formulæ and methods of computation, with the auxiliary tables employed, which will be of the greatest use to Government surveyors in the colony; and his whole Report will be of great assistance to any one who has to conduct similar operations in other parts of the world. The Report is illustrated with excellent lithographic plates of the theodolites, the base-measuring apparatus, Comparateur, triangulation, &c., and the Government printers at the Cape have successfully carried out what must have been to them no easy task.

C. W. WILSON.

IN THE AUSTRALIAN BUSH AND ON THE COAST OF THE CORAL SEAS.[1]

PROF. RICHARD SEMON, of Jena, the author of the above volume, will be well known to biological readers in connection with the valuable monographs that, under the title of "Zoologische Forschungsreisen in Australien und dem Malayischen Archipel," have been produced by himself, Prof. Ernst Haeckel, E. von Martens, and other accomplished collaborators as the outcome of his travels and collections in the aforesaid regions during the years 1891–92.

The treatise under review is written in an essentially popular vein. It is a narrative of his voyage out to Australia; residence in and investigations conducted concerning the fauna of limited districts of that island continent; and of his homeward route, with a detour embracing New Guinea and a considerable area of Malaya. The larger section, associated with the title of "The Australian Bush," deals only with portions of the easternmost of the six Australian colonies, that of Queensland. The main object of Prof. Semon's expedition was the investigation of the embryological phenomena of those archaic zoological types peculiar to the Australian region. The lung-fish, *Ceratodus Forsteri*, and the monotrematous mammals Platypus and Echidna, whose unique, egg-laying habits were for the first time incontestably demonstrated some years since (1884) by our fellow-countryman, Mr. W. H. Caldwell. With this specified end in view, M. Semon proceeded to South Queensland and camped out for several weeks on the banks of the rivers Burnet and its tributary the Boyne, at some little distance from the townships of Gayndah and Coonambula. All three of the zoological types named are indigenous to this watershed (Ceratodus existing nowhere else), and by making liberal use of the assistance of the semi-civilised natives an abundant supply of the materials desired were obtained. While a few of the more salient developmental phases of Ceratodus and Echidna are figured in this volume, their detailed histological delineation and description are relegated to the monographs previously cited.

As the result of the first week's work, and the offered reward of half-a-crown for each female Echidna, one alone of the several natives engaged brought in as many as six of these monotremes, and a large assortment of other animals, altogether making good his claim for eleven shillings, after deducting rations. The outcome of the prompt payment of the rewards earned was somewhat disastrous. During Prof. Semon's absence from the camp the succeeding day, the natives contrived to exchange their hard cash for "fire-water" at the nearest hostelry—an undoubted breach of the regulations on the part of the vendor—and with the consequence that every man, woman and child, some thirty all told, were, on the learned Professor's return, dead drunk. A similar bacchanalian carouse, with threatened hostilities among themselves, is recorded as having followed the payment of the yet more liberal prize of 100 marks (£5), that was awarded to the first of the band of aborigines to bring in the ova of Ceratodus. In the case of such substantial sums being won by natives of such essentially child-like irresponsibility, the proper course would undoubtedly have been to have lodged the money for disbursal for their benefit in the hands of some one of the neighbouring responsible settlers.

In his brief reference to the life-habits of the Echidna, Prof. Semon places on record an interesting demonstration of the conspicuous homing instincts, and also of the travelling capabilities of the species. An example brought into the camp from a distance of no less than 6 kilometres, escaped in the night from the sack in which it was confined. A native following up its track, found it the following morning reposing in close vicinity to the spot where it was originally captured. The data chronicled, though apparently not from direct observation, concerning the food habits of the Echidna, in M. Semon's book, are somewhat at variance with those personally determined. It is here stated that worms and insects of all descriptions (Kerbtieren aller Art), though more particularly ants, constitute its normal pabulum. Also that ants, in the ordinary sense of the term, are devoured after the fashion peculiar to the typical ant-eaters, Myrmecophagidæ. With the several examples kept by the writer for long intervals, and which becoming tame were permitted to seek their nourishment in their native "bush," it was found that these Echidnæ not only limited their attention to ants, but in this connection cared only for the white succulent larvæ and pupæ or, so-called, eggs. Ants in their ordinary adult form, as in a teeming ant-track, would be altogether ignored. At the same time while consuming the larvæ, to gain access to which they tear open the hillocks, or overturn stones with their powerful claws, a considerable number of adult ants may be adventitiously injested.

The quest for the ova of Ceratodus proved to be a more lengthened task. No less than eight months were occupied in obtaining an accurate knowledge of that animal's spawning season, and in registering the developmental features of the ova when obtained. The persevering search, coupled with the handsome reward offered to the natives previously recorded, resulted in the ultimate acquisition of an abundant supply of material,

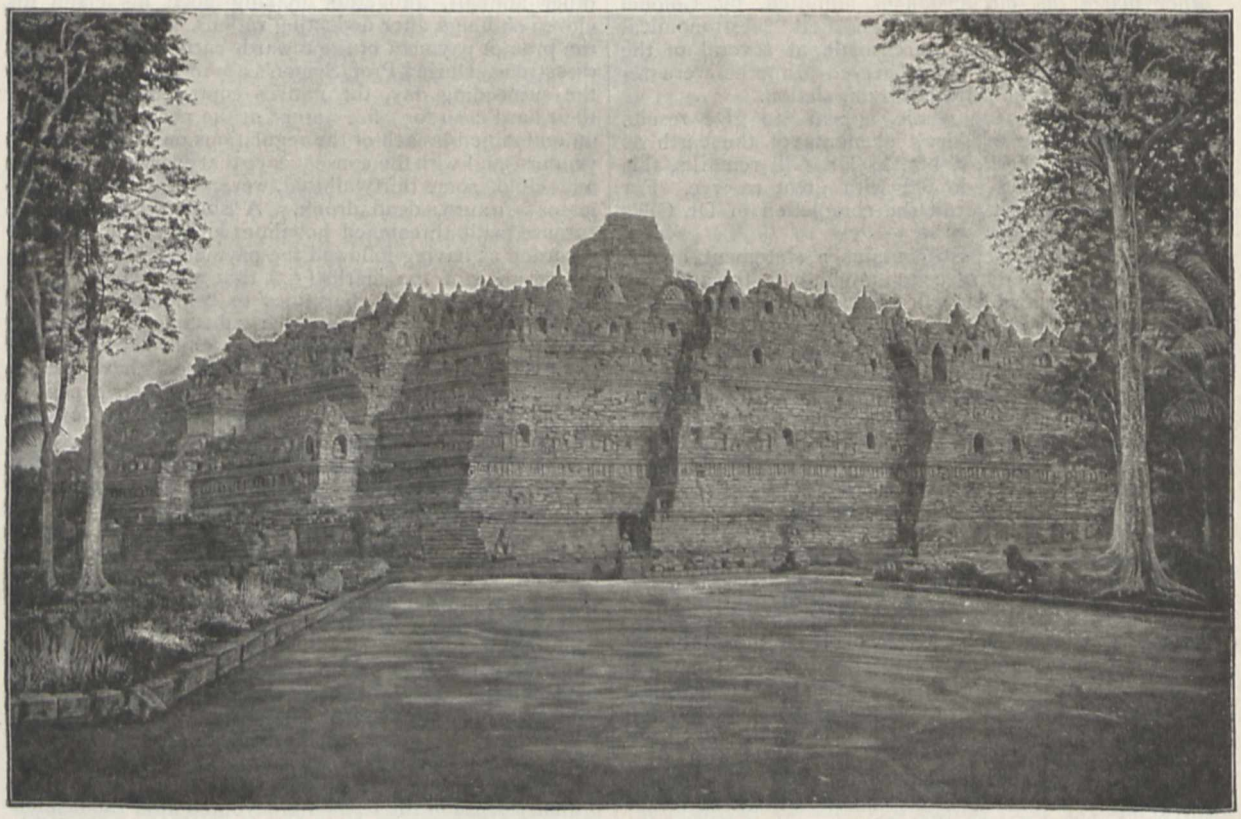
[1] "Im Australischen Busch und an den Küsten des Korallenmeeres-Reiseerlebnisse und Beobachtungen eines Naturforschers in Australien, Neu-Guinea und den Molukken." Von Richard Semon. 8vo, pp. xiv + 556. Mit 85 Abildungen und 4 Karten. (Leipsig: Wilhelm Engelmann, 1896.)

and from which, through the conservation of specimens in suitable receptacles in the adjacent stream, every essential developmental phase was successfully recorded. The time spent in waiting for the spawning of Ceratodus was fully occupied by Prof. Semon in accumulating zoological material of every available description. His book constitutes also a full and interesting narrative of his experiences as a "new chum," or novitiate in Australian bush life, together with an abundance of information on colonial matters generally, in so far as they relate to Queensland. In this manner his descriptions of the fauna and flora are liberally interspersed with popular accounts of cattle mustering and branding, meat freezing works, sugar and gold-mining industries, and even dissertations on sports and politics. The pages of Prof. Semon's volume abound with illustrations, photographs of his camping stations and their environments, of the semi-civilised natives in his employ, and the animals characteristic of the district. It is to be regretted, being as demonstrated an expert with the camera, he should, as is conspicuously evident, have contented himself with reproducing the portraits of the animal forms from mounted or preserved specimens only.

From Southern Queensland, Prof. Semon travelled northward, making a stay of some weeks in the plains and scrublands inland from Cooktown, intent on the collection of marsupial embryological material, and also at Thursday Island for the acquisition of the abundant marine zoological products of Torres Straits. The chapters devoted to these selected centres of investigation constitute, it might be added, a comprehensive gazetteer to the townships of the East Queensland coast. The nature and configuration of the associated coastline receives also a share of notice, including—although deterred by counter-attractions from devoting special attention to this subject—that phenomenal formation the Great Barrier Reef. Prof. Semon concludes his discussion of the Darwinian and newer theories that have been advanced concerning its origin, by a declaration (p. 273) altogether in favour of the Darwinian or subsidence interpretation, as applied not only to the Australian, but to most other Barrier and Atoll reef formations.

Leaving Australia and having visited New Guinea, M. Semon extends his travels to Java, Celebes and Ceram, devoting a considerable time at Amboyna to exploring and collecting in the life-teeming coral seas of that district. A special object of his ambition in these latitudes was the investigation of the developmental history of *Nautilus pompilius*. Unfortunately the time of his visit was not favourable for the acquisition of the desired material, the Nautili being then in deep water. Inquiries elicited the fact that it is only during the south-east monsoon, from May to September, that this Cephalopod enters the shallow coastal waters for the purpose of depositing its spawn. By leaving suitable materials for their conservation, a consignment of half-a-dozen examples of this, in the flesh, rarely-obtained species were subsequently remitted to M. Semon from Amboyna.

The latter portion of Prof. Semon's book abounds with admirable photographs of the characteristic landscapes of the tropical districts visited and described. Mingled with these are a few notable Oriental architectural and social scenes, that of the Javanese rock-hewn Buddhist temple of Boro Budor, shown in the accompanying illustration, being especially fine. With the exception, however, of a drawing of the Robber Crab (*Birgus latro*), no zoological subject is figured, and one is somewhat



Buddhist Temple of Boro Budor, Java.

disappointed that none of the many opportunities occurring were utilised of recording with the camera glimpses of the marine paradise and its wondrous inhabitants that are so abundantly discussed. Photographic replicas of coral scenes and their associated denizens have of late years been shown to be fairly easily attainable, and appeal more intelligibly to the comprehension of the lay reader than a wealth of descriptive text. This shortcoming notwithstanding, Prof. Semon's book may be recommended as a most readable and instructive one to all those to whom the Australian bush and coral strands are *terræ incognitæ*.

Should Prof. Semon contemplate another tropical Australian expedition, we would earnestly recommend him to provide himself with one of the simple mosquito tents, procurable at any of the northern ports. Armed with this device, the night of torture on the Jardine River, so graphically described at page 333 *et seq.*, would have been shorn of all its terrors, the shrill piping of the baffled enemy outside the canvas adding but a zest to the peaceful enjoyment of his otherwise vainly invoked repose. W. SAVILLE-KENT.

THE READING, WRITING, AND ARITHMETIC OF THE NEOLITHIC TROGLODYTES.

A DISCOVERY of great interest has recently been made by M. Ed. Piette, and published by him in *l'Anthropologie* (Tome vii., 1896, p. 385). In a cave at Mas-d'Azil,[1] on the left bank of the Arise, in the Department of Ariège, he excavated a layer of pebbles that had been painted with peroxide of iron in various devices. These occurred above a deposit containing bones of the reindeer, red deer, aurochs, horse, &c., and below a cinder layer, in which were great quantities of a land-snail, *Helix memoralis*, which indicates a somewhat humid climate; above this were deposits, in which polished stone axes occurred, and also *Helix hortensis*, which suggests drier conditions.

The Quaternary Period, according to M. Piette, was divided into two eras—the end of the Glacial Period forming the dividing line.

The intermediate Transition Period commenced when the modern fauna had replaced the glacial fauna; it consisted of three phases: (1) the Cervian, when the implements were of the same form as those of the earlier Quaternary era, and when the hunters of the reindeer made harpoons and needles of reindeer bones, and engraved upon their antlers. The climate then ameliorated, as evidenced by the presence of trees, and the reindeer passed away; and (2) the Asylian phase, or the period of coloured pebbles occurred. By this time man had forgotten the arts of engraving and carving, and commenced to devote himself to cultivation, and painted quaint forms on rolled stones. (3) The Snail-shell phase indicated a warmer humid climate, when vegetation flourished, and man cultivated several kinds of fruit trees.[2] Although the last two layers belonged to the Neolithic Period, polished stone axes were not found in them, though they occurred at a higher level associated, as has been already stated, with *Helix hortensis*.

The ruddled pebbles are mostly rounded, oblong, and flattened pebbles of quartz or schist taken from the bed of the river. In some cases the whole surface is coloured, but most frequently a stone is marked on one or both sides with simple devices. Sometimes the margin of the pebble is painted so as to form a kind of border to the decoration (Figs. 3 and 5).

[1] A description of this remarkable tunnel-like cave was given by M. E. Cartailhac in *l'Anthropologie* (Tome ii., 1891, p. 141). This paper was illustrated by two figures of the cave itself, and by a plate of some of the painted pebbles.

[2] M. Piette has already published a paper on the cultivated plants of the Transition Period at Mas-d'Azil in *l'Anthropologie* (Tome vii., 1896, p. 1).

M. Piette classifies the devices as follows: numerals, symbols, pictographic signs, and alphabetical characters.

(1) *Numerals.*—A large number of stones were found with from one to eight lines (Figs. 1 and 2) running across them. These the author considers as indicating simple numerals. Never have more than eight lines been yet found on a stone. Some of the pebbles are marked with rounded or oval spots (Fig. 3). These are regarded as units of higher groups of figures—either nines, or more probably tens, and the Egyptian system is adduced as an argument in favour of this view. The spots vary in number, one stone bearing as many as twenty-three.

FIG. 1.

FIG. 2.

FIG. 3.

Occasionally marginal blotches were painted. The author's enthusiasm has led him to speculate whether these may not be the squares of the higher grade units; thus, a pebble (Fig. 4) with twelve marginal blotches and six central spots is credited with indicating a total of 1260 in the decimal system; or 1728+60, that is, 1788 on a duodecimal hypothesis. It apparently strikes even M. Piette that these are rather high numbers for the Neolithic troglodytes, and so he suggests that there may be no significant difference between central or marginal spots. As a disc surrounded by a circle has during all

FIG. 4.

FIG. 5.

FIG. 6.

time been considered as the symbol of the sun or of a sun deity, the question is asked, "May not the circles in lines be signs employed in a hieratic writing?" Amongst other suggestions, he speculates whether they may not be meant to denote objects of special value; and, lastly, he seriously proposes the view that these very abundant numeral stones may have been counters in some game. Occasionally these "numerals" are ornamented, as in Fig. 5.

(2) *Symbols.*—M. Piette candidly admits that the conclusions of the "perilous study" of symbolism should

FIG. 7.

FIG. 8.

FIG. 9.

be stated with the greatest reserve. Crosses, especially the equilateral cross (Fig. 7), are abundant, but the *tau* (Fig. 6) also occurs. We need not follow the speculations to which such designs irresistibly lead.

(3) *Pictographic Signs.*—Serpentine designs (Fig. 8) often occur, and M. Piette gives two personal anecdotes to illustrate the persistence of a superstitious regard for snakes in the Pyrenees and in the Department of Aisne. Other identifications are more doubtful, as, for instance, "trees" (Fig. 9), "reeds," &c.

(4) *Alphabetical Characters.*—The most startling section of this memoir is the suggestion that certain designs

painted on some of the pebbles indicate entirely conventionalised phonetic characters. Most of them are isolated markings, as in Fig. 10, which resembles the Greek Π and the Cypriot *go*. In a very few instances two or more symbols are associated together, as in Fig. 11. This is, as a matter of fact, the nearest approach to an inscription. M. Piette makes full use of the recent discoveries of Mr. Arthur J. Evans in early Mediterranean scripts, and we must leave it to experts to discuss the problems opened up by M. Piette's astonishing discoveries. Assuming these markings to be syllabic signs, can it be possible that these pebbles were employed in building up words and sentences, much as children use boxes of letters? The author states that "thirteen out of twenty-three Phœnician characters were equally Asylian graphic signs."

FIG. 10.

FIG. 11.

No longer can markings or designs, made by savage or primitive peoples, be ignored or be superciliously smiled upon as of no moment. We now recognise that such peoples do not while away their idle hours in making meaningless cabalistic signs, or in aimlessly decorating objects. When one looks through the twenty-five beautifully coloured plates of the atlas that accompanies this memoir, the belief is irresistible that these hundreds of pebbles have not wantonly been painted, but that thereon is recorded a hitherto unsuspected phase of prehistoric culture. At times one may feel a little good-natured amusement at the ingenuity displayed by M. Piette; but, at the same time, we respect his enthusiasm, and trust that he may be fortunate enough to bring further evidence to light. A. C. H.

EMIL DU BOIS-REYMOND.

AS was stated in our last issue, Emil du Bois-Reymond, Professor of Physiology in the University of Berlin, and Perpetual Secretary of the Berlin Academy, died on December 26, after a severe illness.

He was born in Berlin on November 7, 1818, where his father, who had begun life as a watchmaker in Neuchatel, had attained an important position. His mother was of Huguenot descent, her family having been driven out of their native country in the seventeenth century. He received his early education at the Collége Français at Berlin, and subsequently at the College of Neuchatel. He entered the university at Berlin when he was eighteen years of age, and was matriculated in the Philosophical Faculty.

At the outset of his university career his pursuits would appear to have been eclectic, for it is stated that he attended Neander's lectures, and was much interested in theology; but about 1837 he took to the serious studies of his life. After a year or two devoted to mathematics, physics and chemistry, he became a pupil of the illustrious J. Müller, and eventually his assistant. In 1841, he was asked by his chief to repeat the observations of Matteucci in his essay "Sur les phénomènes électriques des animaux," which had been published the year before in Paris. This led to the historical studies which he embodied in his dissertation for the degree of D.M. ("Quae apud veteres de piscibus electricis exstant argumenta"), and to the discovery of the main facts of what we now call electro-physiology. His first research on this subject was published in the fifty-eighth volume of *Poggendorff's Annalen*, under the title, "Ueber den sogenannten Froschstrom und ueber die elektromotorischen Fische." During the next ten years he devoted himself entirely to the line of inquiry he had determined to follow. The fruits of his labour were embodied, not in separate papers, but in his great work on "Animal Electricity," which was not completed till about ten years ago, although the first volume appeared in 1848. When, in 1855, he visited London, he had already acquired a European reputation. Some readers may, perhaps, remember the interest excited by a Friday evening lecture, with demonstrative experiments, which he gave at that time at the Royal Institution. In 1858 he succeeded Müller as Professor of Physiology at Berlin, and in 1867 became Secretary of the Berlin Academy. After the Franco-German war the palatial building in the Neue Wilhelmstrasse was erected according to plans which, with much forethought, he had designed, so as to provide for all the branches of physiological teaching and research. These were carried out with a completeness which has made the Berlin laboratory a model for similar institutions in all parts of the world.

About 1878 du Bois-Reymond published his "Collected Papers," in which all the scientific work done by him up to that time is included, excepting what had been recorded in the "Thierische Elektricitat," and in 1881 a volume appeared, shortly after the accident which deprived his assistant, Dr. Sachs, of his life, containing the results of Sachs' experimental investigations of the *Gymnotus electricus* in its native country.

To many readers who have no special interest in the scientific problems which it was the aim of his life to solve, du Bois-Reymond is known by his contributions to literature, and by the admirable literary style of his essays. Of his numerous writings on historical, biographical, and philosophical subjects, we can mention only the best known, such as (1) the historical introduction contained in the first chapters of his great work; (2) the essay on university organisation (1870); (3) on present and past of physiological teaching, and on the relations of natural history to natural science (1878); and (4) on the limits of natural knowledge (1882).

Du Bois-Reymond's life-work was the investigation of the electrical phenomena of animals and plants, and the relation between them and the vital endowments of the structures in which they manifest themselves. The first part of this task he accomplished all but perfectly. As regards the second, he arrived at theoretical conceptions which, although no longer so predominant as they were, still serve as points of departure in all electro-physiological discussions. To exemplify this, we must go back for a moment to the time fifty years ago, when he undertook the experimental criticism of Matteucci's work. Recognising that the electrical properties which had been described by his predecessors with relation to the whole organism could only be understood by referring them to the parts in which they manifested themselves, he at once limited his inquiry to the electromotive properties of the muscles, choosing for his purpose those of simplest construction—those which consist of parallel fibres. Considering that in such a muscle each fibre must be an epitome of the whole, and that if it were possible to break up a fibre into its constituent fibrils, its properties would also represent those of the whole, and having found experimentally that the surface of a cylinder obtained from a living cylindrical bundle of fibres by cutting it across in two places, exhibited in different parts differences of potential which could be expressed by a very simple law (the so-called law of the muscle current, according to which the centre of each cut surface is negative to every other part), it required but little use of the scientific imagination to suppose that if the cylinder contained elements of indefinite minuteness endowed with properties corresponding to its own, the result would

be as observed. He thus arrived at the theory of electromotive molecules which, with extraordinary insight and thoroughness, he worked out in its relations to all the electromotive phenomena of nerve and muscle when in the unexcited state. But, in doing this, he met with unexpected difficulties. So long as his observations were limited to the properties of the muscle cylinder the theory was applicable; a model could even be constructed of schematic molecules which displayed all the phenomena of the "cylinder" of living muscle; but in the natural muscle certain "parelectronomic" facts, to use du Bois-Reymond's word, presented themselves, which to this day are irreconcileable.

In connection with the molecular theory of the muscle current, he discovered the elementary facts relating to what is called stimulation or excitation, viz. that when a muscle is excited, whether naturally or artificially, the sudden shortening of its fibres is ushered in by still more sudden electrical changes. This phenomenon du Bois-Reymond succeeded in connecting with those of the muscle cylinder by means of the theory above referred to. According to his view, when a muscle is excited, each of its electromotive elements sustains a diminution of its E.M.F., the result of which is that in the muscle cylinder so excited the pre-existing difference between its cut-surface and its natural surface diminishes. Here again the progress of investigation has shown that while some of the electrical phenomena of excitation require such a theory for their explanation, it does not cover the whole ground; for which reason many physiologists decline to assign to it its true value.

A third theory of very wide application relates to the way in which electric currents when used as stimuli act on nerves. It was recognised by du Bois-Reymond that a voltaic current led through a nerve, although it produces those remarkable changes in its electromotive properties which are called electrotonic, fails to excite it to action so long as the current strength remains constant, but that the slightest increase or diminution of current strength excites it with an intensity which is inversely proportional to the time occupied by the change. Under certain conditions he found that his experimental results were in such strict conformity with the principle laid down as to justify their being embodied in a mathematical formula. But even here we now know that this "law of excitation" is not of universal application.

We have referred to these instances for the purpose of pointing out that du Bois-Reymond's real greatness consisted, not in his theories, but in the exactitude of his observations, the excellence of the methods which he devised, and the number of new relations which he discovered between physical and vital phenomena. Just as Ludwig taught us how to investigate the mechanics of the circulation, and Helmholtz how to determine the time-relations of physiological processes of very short duration, so du Bois-Reymond not only opened to us a new field of investigation, but furnished his contemporaries and successors with the means of cultivating it. For this service we can best show our gratitude by striving to work as he did, never allowing theory to influence our judgment in the interpretation of experimental data, and never contenting ourselves with inadequate methods of observation. In investigations of such difficulty mistakes are unavoidable, and it cannot be asserted that in his fifty years of active work du Bois-Reymond never fell into any errors of observation; but if we compare these with the new truths which he brought to light and established, their importance seems indeed trivial. There can be no more striking proof of the solidity of his achievements than the fact that, notwithstanding the large number of active workers who, during the last few decades, have been engaged in physiological researches, the instruments and methods which he devised are still in use. In every laboratory you find his "Schlitten inductorium," his non-polarisable electrodes, the du Bois key, and the du Bois compensator.

Like other great teachers, du Bois-Reymond founded a school; although his pupils were far from being as numerous as those of Ludwig, they occupy very important academical positions. The man who probably has done more to maintain the influence of his doctrines than any other is Prof. Bernstein, of Halle, whose "Untersuchung über den Erregungsvorgang," published in 1871, was comparable in importance to that of Hermann's research on muscle physiology, published a few years earlier. It is noteworthy that each of them dedicated his research to du Bois-Reymond—the one afterwards to become his energetic opponent, the other then and now his cordial supporter. If on any one the mantle of du Bois-Reymond falls, it must be on Bernstein.

J. BURDON-SANDERSON.

NOTES.

THE elevation of Sir Joseph Lister to the Peerage is a New Year's honour which has been received with the keenest satisfaction in the scientific world. It may be taken as an acknowledgment by the Crown of the high position of the President of the Royal Society, as well as a recognition of the life-long work in science which led to Sir Joseph Lister's selection for that honoured Presidency.

AN address of congratulation, signed by a number of eminent men of science, and by leaders in other branches of learning, has been presented to Mr. Herbert Spencer, in recognition of the successful completion of his "System of Synthetic Philosophy." With reference to this work it is remarked in the address: "Not all of us agreeing in equal measure with its conclusions, we are all at one in our estimate of the great intellectual powers it exhibits, and of the immense effect it has produced in the history of thought." The signatories requested Mr. Spencer to permit them to employ some eminent artist to take his portrait, with a view to its being deposited in one of the national collections. Though at one time averse to a proposal of this kind, Mr. Spencer has now given his consent in a letter to Sir Joseph Hooker, who forwarded the address, and Mr. Herkomer, R.A., has undertaken to paint the portrait. It is gratifying to know that the country will possess an authentic personal likeness of so distinguished a philosopher. Donations for the portrait fund may be sent to the Bank of England, Burlington Gardens, W.

THE distinguished Berlin astronomer, Prof. Dr. Arthur Auwers, has received from the German Emperor a gold medal for his services to science.

M. CALLANDREAU, professor of astronomy at the Paris École Polytechnique, has been elected a Correspondant of the St. Petersburg Academy of Sciences.

THE Council of the British Institute of Public Health have awarded the Harben medal for 1897 to Prof. M. von Pettenkofer, Emeritus Professor of Hygiene in the University of Munich.

IT is understood that Mr. Herbert Goss and the Rev. Canon Fowler, who have been joint Secretaries of the Entomological Society for the past eleven years, do not intend to offer themselves for re-election at the next annual meeting of the Society on the 20th inst.

WE regret to announce the deaths of Dr. Luigi Calori, professor of anatomy in Bologna University; Dr. G. D. E. Weyer, professor of mathematics and astronomy in the University of Kiel; M. Vivien de St. Martin, renowned for his researches in ancient geography; and Mr. Theodore Wormley, of Philadelphia, well known as a chemist.

M. GASTON TISSANDIER, who for the last quarter of a century has presided over the destinies of *La Nature*, has just retired from the editorship, and M. Henri de Parville has succeeded him. It is not proposed to make any changes in the character of the journal, and the traditions which have secured for *La Nature* a high degree of success and prosperity will be followed by the new editor.

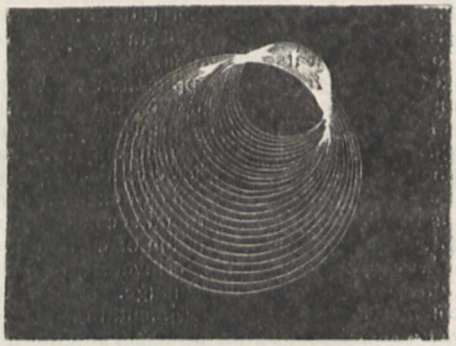
BY leaving almost the whole of his fortune to be converted into an international fund for the advancement of scientific research, the late M. Alfred Nobel performed an act for which his memory will be cherished in the world of science. According to the terms of the will, as reported by Reuter's correspondent at Stockholm, a fund is to be formed from all his realisable property, the yearly interest from which is to be divided into five equal portions. The first of these is to be allotted as a prize for the most important discovery in the domain of physics. The second is for the principal chemical discovery or improvement. The third is for the chief discovery in physiology or medicine. The fourth is for the most distinguished literary contribution in the same field; while the fifth is to be allotted to whomsoever may have achieved the most, or done the best to promote the cause of peace. All these prizes are open to Scandinavians and foreigners alike. After a few bequests to individuals have been deducted, it is expected that the fund thus devised will amount to the sum of 35,000,000 kroner, or nearly two millions sterling. The result of this very generous endowment to science will be an ever-growing monument to M. Nobel, built up of contributions to natural knowledge; a monument, too, which will stand out as a testimony of broad-mindedness and devotion to science. M. Nobel was cosmopolitan in more ways than one, for he was the master of seven or eight languages. He was a Swede by birth, having been born at Stockholm in 1833. A very appreciative article in the *Ardrossan and Saltcoats Herald* of December 25, evidently written with authority, contains a list of his researches and inventions, and some interesting notes on his personal characteristics. M. Nobel was educated at St. Petersburg, and subsequently assisted his father in his engineering shops at Stockholm, and was little over thirty years of age when he became identified largely with explosives. On May 7, 1867, he published his great "Dynamite, or Nobel's Safety Powder" paper, which inaugurated a new era in the entire world of explosives, and in many branches of engineering. His blasting gelatine patent followed in 1875; and the invention of Ballistite, a smokeless propelling powder, was patented in 1888. M. Nobel was never married.

WE are glad to announce another gift to science. The Paris correspondent of the *Times* states that the widow of Baron Maurice Hirsch, of Vienna, has resolved to present 2,000,000 francs to the Pasteur Institute as a memorial of her husband. This will enable the building to be enlarged by chemical and biological laboratories, which, it is estimated, will cost 800,000 francs. Some of the professors, moreover, at present receive little or no salary. The gift comes at a very appropriate time, and it could not have been bestowed upon a worthier object, nor could a better memorial be found, than the Pasteur Institute.

THE twenty-fourth annual dinner of the old students of the Royal School of Mines will be held at seven o'clock on Tuesday, January 26, at the Criterion Restaurant. The chair will be taken by Dr. T. K. Rose. Tickets may be obtained from Mr. H. G. Graves, 5 Robert Street, Adelphi, W.C.

QUITE recently a considerable number of additions to our knowledge of the Röntgen rays and their applications have been published. From Prof. Hobday we have just received a reprint of his and Mr. V. E. Johnson's joint paper in the *Veterinarian* for September, dealing with the use of these rays in veterinary practice, illustrated by several excellent radiographs of the hoof and hock of horses, both normal and abnormal. In the *Bulletin* of the Belgian Royal Academy, M. L. N. Vandevyver enunciates the empirical law that the length of exposure for radiographs through limbs of different dimensions varies as the cube of their thickness, and the illustrations which accompany the paper afford ample corroboration of the law from a practical point of view. The *Journal of the Camera Club* for December contains the account of a lecture, by Prof. Rücker, on the transparency of glass and porcelain to these rays, from which it appears that the presence of phosphates in china is indicated by their greater opacity, a result which might naturally be expected to follow from the considerable opacity of bone to Röntgen rays. M. Bouchard, in a communication to the Paris Académie des Sciences, states that Röntgen rays can be successfully employed in diagnosing pleurisy and similar complaints.

A CURIOUS optical phenomenon is exhibited by the accompanying tracing, made by a finely-pointed top spinning on a plate of glass covered by a light coat of lampblack, and sent to us by Dr. C. B. Warring. If the spiral is looked at with either eye, the other being closed, one seems to see the inside of a hollow truncated cone, the smaller base being farthermost; or else only the outside will be seen, the smaller base being



apparently nearest. If the eyes be opened and closed alternately, the image may appear to each in the same position, perhaps for half-a-dozen alternations, and then, without apparent cause, reverse, or it may reverse for one eye and not for the other. If both eyes be opened, only one image may appear, sometimes in one position and sometimes in the other. The principle seems to be the same as that which applies to a polished hemisphere laid on a plane surface, and looked at from a little distance.

AT a meeting of the Société Française de Physique, on December 4, M. Jean Perrin described his investigations on the dissociation of neutral electricity produced in gases by Röntgen rays, to which their power of discharging insulated conductors is due. At constant temperature the quantity of dissociated electricity per unit volume is *cæteris paribus* proportional to the pressure, and hence to the density of the gas. At constant pressure it is independent of the temperature, and since the density is inversely proportional to the absolute temperature, it follows that the quantity dissociated per unit mass is independent of the pressure, and varies as the absolute temperature. At the same meeting, M. Broca made some interesting statements about the baldness produced by Röntgen rays, which is caused by the hairs falling off with the skin. The scars are sometimes not produced till three weeks after the skin was exposed to the rays, and where the cuticle is replaced by cicatrised tissue the hairs disappear; but they grow up again everywhere else, so that the rays cannot be used for depilatory purposes.

THE influence of light upon the discharge of electrified bodies has formed the subject of many investigations since Hertz observed the effect of ultra-violet light upon the spark of an induction coil, less than ten years ago. Since then an extensive literature of the subject has grown up, though only a few of the more important papers are in English; so it is difficult to determine how far the knowledge of the phenomenon has progressed. For this reason, and in view of the evident importance of the subject, Mr. Ernest Merritt has prepared an account of the investigations which have thus far been published; his very useful summary appearing in *Science* of December 11 and December 18, 1896. It appears from this account that a thoroughly satisfactory explanation of the discharging action of light has not yet been found, and that many questions concerning the phenomenon remain to be settled by further experimental investigation.

THE January number of *Science Progress* opens with an article, by Prof. H. A. Miers, F.R.S., on Dr. Lehmann's "Liquid Crystals." Two of these remarkable bodies are azoxyphenol and azoxyanisol. When crystals of azoxyphenol are warmed on a microscopic slide, they are suddenly transformed, at a temperature of 134°, into a substance which preserves the outline of the crystal, is strikingly doubly-refractive, and behaves like a true crystal when rotated between crossed Nicols, but is nevertheless a liquid. If the preparation be still further warmed, it passes at 165° into a third modification which is also liquid, but not doubly-refractive. It is possible to contrive that this molten substance shall contain small portions of the first, birefringent, liquid which float about in it as perfectly spherical drops, and are regarded by Lehmann as really liquid crystals. Crystals of azoxyphenol behave in a similar way, the changes taking place at 116° and 134°. The investigation of these curious birefringent liquids has an important bearing upon current views regarding the structure of solids and liquids.

BALMOKAND, a cloth-seller of Rawalpindi, has written a remarkable brochure, entitled "The Priceless Gem" (The Mitra Vilasa Press, Lahore), which advocates what may be regarded as a "puritanical" movement in modern Hinduism. It would be easy to indite a cheap criticism of the literary style, the authorities quoted, and of the translation from the original Urdu into "baboo" English, but it is a more grateful task to recognise and make known the serious aim of the author. Being struck by the contrast between the former learning, wealth and power of ancient India, and her present "ignorance, indolence, indulgence . . . with all other vices and evils," Balmokand, by "long contemplation and continuous thought," came to the conclusion that this is due to disregard of the ancient *Baran* custom; by which a man and woman of similar *baran* being joined in marriage "should become for their whole life a loving and affectionate couple." The author waxes eloquent on the joys of a happy marriage, and on the chivalrous protection, courtesy and deference that is due to woman from man, and sustains his position by quotations from the Hindu sacred writings. He is also strong on the crime of infant marriage, and relies on ancient authority for maintaining that neither sex should marry before the twenty-fifth or twenty-sixth year. Most of the ills of modern India are ascribed to the breaking up into innumerable castes of the four primitive *barans*—Brahmin, Kshatrya, Vaisha and Sudra. The psychological and religious tendencies of the members of the four *barans* are described, and the decadent social groups produced by various degrees of miscegenation are detailed. The four primitive castes were communities of relationship; he would resuscitate the classes, but would admit entrance into them by the casting of a horoscope. The selection of suitable partners in life is rightly regarded as a most important matter which affects family happiness and the well-being of the next generation; this selection is, however, not to be made by wise consideration in the European sense of the term, but, like all the other events of life, is to be determined by divination. The main interest of the pamphlet lies in the picture that it gives of the working of the mind of an enthusiast and visionary belonging to an entirely different world from our own; it is a practical lesson in comparative psychology.

A GRAVE-FIND at Vitzke, in Altmark, probably belonging to about the end of the fourth century of our era, is described and figured by E. Krause in *Globus* (Band lxx. Nr. 17). In the same number of the journal is the annotated translation (in German) of the Polynesian song of the saving of Nga-Upoko-E-Rua, the daughter of Potikitanas, in which are embodied myths of origin. Dr. A. Vierkandt follows with a sociological study on the family. The succeeding number of *Globus* has an illustrated article showing the skill in portraiture of the ancient Egyptian sculptors. P. Dittrich contributes a study of the plans of houses and of rudimentary courtyards in Schlesien. Schlesien was originally a German land; during the wandering of the peoples it was peopled by Slavs, but later, especially in the west, German influence made itself felt. It is not too soon that such investigations have been undertaken, for the thrashing-machine is replacing the flail, and gradually the history of the old culture will become obliterated. Would that we had such investigations in our own islands!

SOME experiments have been made by Wernicke on the vitality of cholera vibrios under particularly interesting conditions. A model aquarium was constructed, and in it water-weeds of all descriptions were planted; it was supplied with fish, and there was no lack of ordinary water bacteria, in addition to which about five milliards of cholera germs were introduced. The vessel and its contents stood in the laboratory, and was exposed to both diffused light as well as to direct sunshine. Nearly three months after the cholera vibrios had been added, they could be detected in the water, as also on the water-weeds; whilst even after the lapse of three months they were isolated from the mud at the bottom. Later, however, all traces of them disappeared. Wernicke is of opinion that mud affords a very suitable nidus for the preservation of cholera vibrios, and believes that, had he allowed less light to gain access to his glass vessel and its contents, he would have identified them even longer; doubtless in the beds of rivers they would preserve their vitality for a considerably longer period. No alteration, either in their morphological or biological functions, could be traced in these cholera vibrios in consequence of their surroundings; but whilst Wernicke states that they were highly virulent when they were first introduced, he unfortunately omits to say if their pathogenic properties suffered any diminution in the interval.

"THE principal household insects of the United States" are described by L. O. Howard and C. L. Marlatt in *Bulletin* No. 4, published by the United States Department of Agriculture. The work contains numerous original observations, and will interest the European reader by giving him a clear and trustworthy account of some of the insect pests which infest houses in the Southern States of America. Among the insects which are equally well known in Europe and America is the bed-bug, which Prof. Marlatt informs us was said by Kalm in 1748 to be plentiful in the English colonies and in Canada, though unknown among the Indians. We believe there is evidence of its having been abundant in Jamaica early in the last century. Prof. Marlatt thinks that the irritation caused by its attacks is due simply to the puncture, and that no poison is injected; but this is certainly an open question, and requires further investigation. A far more formidable insect, however, is *Conorhinus sanguisuga*, Leconte, called by

Marlatt "the blood-sucking cone-nose," a near ally of the well-known Chilian Bug, *C. Renggeri*, and very similar in its habits, attacking insects and vertebrate animals almost indiscriminately. It belongs to the same family as our Wheel Bug (*Reduvius personatus*), and, like the latter insect, is common in outhouses, and will, on occasion, feed on the common bed-bug. Our insect, however, is much smaller, and rarely attacks man. American houses are also commonly infested by a curious long-legged centipede, *Scutigera forceps*, belonging to a family represented in South Europe, though not in England. However, it only seems to bite in self-defence, and is therefore a less objectionable visitor than might be supposed. White ants, which have, happily, not yet effected a lodgment in England, are as destructive in America as in many other parts of the world; but are too well known to need special notice here. Much more interesting matter will be found in this important little *Bulletin*.

"VERITYS' Conversion Table" (designed by Mr. M. B. Cotterell) shows graphically the prices of wire and cable per yard, coil, or mile. By means of this simple diagram, it is easy to find the price per coil and per yard of a cable quoted at any price per mile. Every maker of electrical fittings should hang up a copy of the diagram in his office, for as a ready reckoner it will prove very serviceable.

A THIRD edition of "Our Secret Friends and Foes," by Dr. Percy Frankland, F.R.S., published in the S.P.C.K. Romance of Science Series, is now in the press, and will shortly be issued. A new chapter has been added, in which diphtheria-antitoxin is dealt with, as well as Calmette's investigations on snake poisons and their treatment by anti-venomous serum. Dr. Nobbe's recent researches on root-nodule bacteria are described in detail, whilst milk-bacteriology in its latest developments is also enlarged upon.

UNDER the editorship of Dr. J. H. Bechhold, a new German weekly journal—*Die Umschau*—has made its appearance. It is proposed to survey the developments and advances of pure and applied science, literature and art, by interesting articles and notes. The first number of the new periodical contains among the articles, "Völkerkunde," by Dr. Max Buchner; "Die Physik der Himmelskörper," by Dr. Huggins, put into German by Marie Bechhold; and "Die Heimat der Germanen," by Dr. J. W. Bruinier.

TWO considerable additions have recently been made to the literature of limnology. In the *Mittheilungen der k.k. Geographischen Gesellschaft* of Vienna, Herr Eberhard Fugger publishes a paper on mountain lakes, which is for the most part a summing-up of conclusions based on extensive observations made on the lakes of Salzburg and the High Tauern during 1891, 1893, and 1895. The causes of origin of such basins are discussed in detail, and their life-history traced through various stages either of continued extension by erosive action, or of gradual filling up. The typical rock-basin is to be regarded as an interruption of the work of forming a valley.

IN the above-named journal Dr. K. Peuker draws attention to the work of Dr. W. Halbfass on the lakes of Northern Germany, especially the Arendsee and the lakes of the Elbe basin. The Arendsee is found to be the deepest lake known in Northern Germany, its mean depth from 1200 soundings being 29·3 metres, and greatest depth 49·5 metres. The extreme concavity of the basin serves to account for remarkable variations in the temperature of the water.

THE ninth edition of the list of vertebrated animals now or lately living in the Gardens of the Zoological Society of London has just been published by the Society. It constitutes "a nearly complete catalogue of all the species of vertebrates of which specimens have been exhibited in the Society's menagerie during the past thirty-four years." The first edition of the list was issued in 1862, and it contained 100 pages and comprised 682 species. The present edition runs into more than 700 pages, and contains references to 3044 species, 770 of which are mammals, 1676 birds, 420 reptiles, 80 batrachians, and 98 fishes. There are also seventy woodcuts in the volume. The list is of service not merely as an indication of the animals which have been kept in the Society's Gardens, but also for references to descriptions of them.

WE have received from Prof. Sresnevsky, Director of Dorpat Observatory, an excerpt paper upon the greater oscillations of barometric pressure during the year 1887. The investigation has been undertaken in the interest of weather prediction. It is well known that successful weather forecasting depends chiefly upon the prediction of the direction which the centre of an atmospheric disturbance will follow. There are various indications which sometimes allow of the determination of this path, but many of the rules are of an empirical nature. The author has investigated these indications by means of the observations published in the Russian Weather Reports, and has embodied the results at which he has arrived in a useful communication to the *Bulletin* of the Imperial Society of Naturalists of Moscow.

THE Government Observatory, Bombay, has just issued its thirty-fourth volume, containing the results of the magnetical and meteorological observations for the year 1895. This institution has kept up an uninterrupted record of systematic and trustworthy magnetic and meteorological observations for the last fifty years, and the results are condensed in a valuable appendix to the present volume. The maximum temperature recorded during this period was 100·2° in 1857, and the minimum 53·3° in 1847. The average yearly rainfall is 72·44 inches, and the annual values vary from about 41 inches to 115 inches. The maximum fall in one day amounted to 16 inches, in June 1886. The Observatory owes much of its present reputation to the valuable contributions in terrestrial magnetism and meteorology of Mr. Charles Chambers, the late Director. We notice that, with the exception of Mr. Moos, the present Director, the staff is composed of native assistants.

THE General Report on the operations of the Survey of India during the year ending with September 1895, has just been received. In this period the aggregate area surveyed on all scales amounts to 125,384 miles, exclusive of 5018 square miles embraced by traverse operations in the Central Provinces and the North-western Provinces and Oudh. In the trigonometrical surveys, the Upper Burma principal triangulation was carried northwards as well as westwards through Manipur and Assam. In addition to the topographical work accomplished during the year, a detachment with the Pamir Commission surveyed 250 square miles, and one with the Chitral Relief Force surveyed in detail 450 square miles on the 1-inch scale, 215 square miles on the ½-inch scale, and, approximately, 1900 square miles on the ¼-inch scale. The results of the operations of the latter surveyors is that considerable knowledge of the topography has been gained of an area of 3600 square miles of a country previously practically unknown, and much credit is due to Captain Bythell and the men who served under him for such a satisfactory record of work. Two views, representing the Malakand Pass and the Chitral bridge and fort, have been reproduced by heliogravure to illustrate Captain Bythell's report. A mass of information on the forest survey operations, cadastral surveys, traverse surveys, longitude observations, geographical surveys and reconnaissances, carried out by the Survey Department under the direction of Colonel C. Strahan, R.E., Surveyor-General of India, is included in the General Report.

SEVERAL Bibliographies, lately received, show that serious and increased attention is being given to the organisation of scientific literature. One admirable and very useful work of this kind is a "Catalogue des Bibliographies Géologiques," prepared under the direction of M. Emm. de Margerie, Secretary of the Commission Internationale de Bibliographie Géologique, in conformity with a vote taken during the International Congress at Washington in 1891. The volume is chiefly made up of descriptive lists of publications arranged according to regions, those in each region being in turn classified according to subjects and authors. The contents fill 732 pages. The work is primarily intended for distribution among members of the Geological Congress; so only a few copies are for sale, these being obtainable from either Messrs. Dulau or Messrs. Friedländer. As expressed by the title, it is not a bibliography of geology, but a bibliography of geological bibliographies, using this latter designation in its widest sense. The volume may thus be regarded as the key to geological literature, and it will doubtless prove of great service as the means by which geologists will be able to unlock their stores of knowledge.—The second volume of the "Bibliotheca Geographica," prepared by Herr Otto Baschin, and issued by the Gesellschaft für Erdkunde zu Berlin, has also come to hand. The plan of the work, which refers to the geographical publications of the year 1893, is the same as that of the first volume, except for a few minor changes in the system of classification; but while the previous volume contained 13,800 entries for the years 1891 and 1892, the present has over 10,000 for 1893 alone. Herr Baschin invites the authors of geographical papers published in journals, and in Transactions not restricted to that branch of science, to forward full titles and references to him at "Schinkelplatz 6, Berlin, W."—A répertoire of physiological works published in 1895, has been prepared by Prof. Ch. Richet. In this "Bibliographia Physiologica" (Paris: Felix Alcan) the publications are classified according to Dewey's decimal system, and Prof. Richet urges authors to give their papers numbers based upon this plan. It is proposed to publish very shortly similar bibliographies of physiology for 1893 and 1894. The first part of the bibliography for 1896 was received a few days ago. Authors are requested to send copies of memoirs on physiological subjects to Prof. Ch. Richet, Faculté de médecine de Paris, and so assist to make his catalogues as complete as possible.

THE additions to the Zoological Society's Gardens during the past week include a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Miss E. M. Tuely; eight Grooved Tortoises (*Testudo calcarata*) from South Africa, a Bearded Lizard (*Amphibolurus barbatus*), seven —— Lizards (*Amphibolurus*, sp. inc.), two Great Cyclodus (*Tiliqua gigas*), six Lesueur's Water Lizards (*Physignathus lesueuri*), a Death Adder (*Acanthopis antarcticus*), a Purplish Death Adder (*Pseudechis porphyriacus*), a Short Death Adder (*Brachyaspis curta*), three Brown Death Adders (*Diemenia textilis*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE OF AUGUST 9, 1896.—M. Deslandres, who was commissioned by the Bureau des Longitudes to proceed to Japan and make observations of the total solar eclipse visible there on August 9 last year, gives in *La Nature* for December 26 a short account of the expedition in general and a brief description of the results obtained. The station decided upon was the small port known as Yesashi, on the northern side of the island of Yézo, where the Japanese party under Prof. Terao and the American expedition were eventually located. During their stay of six weeks there were only eight fine days, so that the previous meteorological reports, which indicated the bad climatic conditions of the island at this season, were entirely corroborated. As we all know, the sky was cloudy during the time of totality, but the French party was more fortunate than the Norwegian observers, for their clouds were evidently not so dense as those which obscured the sun at Vadsö and Kiö. M. Deslandres, who was directing the observers under him, saw at a glance that it was useless to proceed in the programme previously arranged for under fine weather conditions. He therefore gave instructions that in the different instruments a single sensitive plate should be exposed for the entire duration of totality. Of the plates exposed, six showed the corona "plus ou moins fort," while on the remainder nothing was seen after development. The negatives indicated dim extensions in the north-west, north-east, and south-west directions, but practically only the general distribution of the coronal light was shown. The images of Venus and Jupiter were also found recorded on two of the negatives. The eclipse of 1896, as M. Deslandres says, confirms the following law, indicated already to a certain extent in previous eclipses, namely, that the periodical variations of the spots which are followed by the prominences extend to the corona, and therefore also to the entire solar atmosphere.

THE MELBOURNE OBSERVATORY.—The thirtieth report (May 1895–June 1896) of the Board of Visitors to the Melbourne Observatory, shows that since the large reduction of the staff which has taken place during the last two or three years, the work of the observatory has had to be necessarily limited. Mr. Baracchi, who is the acting astronomer, has nevertheless been able to cope with the existing circumstances and carry on, at any rate, the most important work and supply the local requirements for meteorological statistics and other scientific matters. Reference is also made in this report to the existence of a large amount of valuable work which is yet unpublished. Besides over thirty years' records in terrestrial magnetism and valuable investigations bearing on the climate of the colony, there is the important work of measurement of the photographic plates of southern zone stars, which is the Melbourne portion of the great international undertaking of the photographic chart of the heavens. There seems also to be a great mass of material unpublished concerning the work done with the great reflector; this consists, as we are told, of finished drawings of nebulæ, sketches, notes, and micrometric measurements "only a minute portion of which has been published." It is sad to read that "observations with the great telescope and other equatorials must for the present be abandoned, and that even if the extra assistance asked for be granted, we shall only be able to barely fulfil already accepted obligations." Perhaps some public-spirited person will offer financial aid to tide over the present difficulties.

MISTS ON MARS.—A circular from Kiel, dated December 27, reports the following information received from M. Flammarion:—"M. Flammarion announces mists (brouillards) on Mars extending to various distances round the polar cap. This whitish zone, less brilliant than the polar snow, extends to a great distance from the pole, and finally vanishes. One might easily mistake it for an extension of the polar cap itself, and this is what has occurred in old observations. M. Antoniadi has made some accurate measurements at Juvisy."

THE ATMOSPHERIC ABSORPTION OF LIGHT.

IT is well known that there are some circumstances, connected with photometric observations, calculated to make us doubt whether, theoretically or observationally, we have determined correctly the amount of light that is extinguished in its passage through our atmosphere. Foremost amongst these considerations may be mentioned the fact, pointed out some time since by Prof. Seeliger, that the very accurate and trustworthy observations made by Dr. Müller, at Potsdam, with a view to determine this quantity, are not rigorously represented by the theoretical expressions derived by Laplace. The deviations may not be large in amount, but they exhibit a systematic character which is suspicious. In the same connection may be mentioned the initial objection, urged by Prof. Langley, that the fundamental expressions used in those investigations are not equally applicable to light of all wave-lengths. There are, further, in use different numerical values of the coefficient of transmission, pointing either to various degrees of transparency in the atmosphere, or to peculiarities in the instruments themselves, or the methods employed in the reduction of the observations.

This question of the discordance between theoretical and observed results has been recently treated by Dr. Hausdorff, and greater importance has been given to the memoir by a review from Dr. Kempf, in a recently-issued *Vierteijahrsschrift;* and this last, while traversing some of the views of the authors, is, on the whole, as satisfactory and reassuring as the views of Prof. Langley and Dr. Seeliger have been disturbing. Dr. Hausdorff, concerned to reconcile theory and observation, examines in the first place Laplace's theory with great accuracy to trace whether the deviations are due to any incompleteness in the theory itself. The principal result of this inquiry is to add a term of rather complex character to the simple formula to which Laplace reduced his expression for atmospheric absorption, but which avails nothing, either in actual practice or in offering a solution of the original difficulty. The new coefficients might be of use if their physical interpretation added anything to our knowledge of the atmosphere; but whether this be assumed of infinite or limited extent, the whole effect of the new introductions, even in small altitudes, can be represented by an alteration in the constant. How little improvement, if any, the consideration of terms of a higher order has had on the computed quantities, is shown by the following table, in which Müller's observed values of atmospheric absorption (M.) (expressed in logarithms) are compared with those of Hausdorff (H.), and the more simple expressions of Laplace (L.).

Z.D.	(M.)	(H.)	(L.)	(M.)-(H.)	(M.)-(L.)
0	0·000	0·000	0·000	0	0
20	0·004	·005	·005	− 1	− 1
40	0·024	·023	·024	+ 1	0
60	0·092	·076	·077	+16	+15
70	0·180	·146	·147	+34	+33
75	0·261	·215	·216	+46	+45
80	0·394	·350	·352	+44	+42
82	0·477	·447	·448	+30	+29
84	0·607	·597	·598	+10	+ 9
86	0·846	·856	·855	−10	− 9
87·5	1·176	1·209	1·200	−33	−24

Practically identical figures result whether the atmosphere be supposed infinite or of limited extent.

The essential service that Dr. Hausdorff has rendered is to show that any considerable improvement in Laplace's theory is not probable. Dr. Kempf now renders a still greater service by showing that any improvement is not needed. He raises the question whether these observed discrepancies are not rather due to observation, and removable by more appropriate methods of discussing the observation. Dr. Kempf remarks that the only observations available for examination are those of Dr. Müller, whether made at Potsdam or on the Santis. Seidel is brushed aside with a scanty reference. Pickering and Pritchard do not get even this recognition. It would probably be objected to the latter that he had not observed below 75° Z.D., and it is only after this altitude is passed, that the deviations between observation and theory become of noticeable amount. But Prof. Pickering's observations of circumpolar stars at upper and lower culminations seem to be available, and should not be rejected without reason or excuse. But it may be urged that the real object of the inquiry is to explain Dr. Müller's observations, and from the connection that has long existed between Drs. Kempf and Müller, the remarks of the former become the more valuable, since it may be assumed that Dr. Müller is cognisant of the treatment that his observations have received at the hands of his coadjutor, and has tacitly acquiesced in the process.

Dr. Hausdorff has declined to use the Santis observations, because the corrections for light extinction are founded on Laplace's theory; but Dr. Kempf shows how the observations can easily be made to furnish results independent of any theory, and consequently the discrepancies between the observations and Laplace's values can be easily exhibited. Expressed as light ratios in logs., the unit corresponding to the third place of decimals, the differences Müller-Laplace are shown in the following little table, in which no regular systematic progress is noticeable.

Z.D.	(M.-L.)	Z.D.	(M.-L.)
18°·6	−10	62°·8	−10
29·3	+ 6	72·4	+ 9
37·2	− 5	79·5	+ 3
44·6	0	82·9	+ 6
57·6	+ 3	85·8	− 7

Not only are the differences small, but in no case do they exceed twice the probable error derived from the discussion of the observations themselves. Encouraged by this satisfactory agreement, Dr. Kempf applies himself to the Potsdam results, and recalls the fact that the extinction table, on which Dr. Hausdorff so much depends, is really the result of the combination of two separate processes of observation. The first part extends from the zenith to an altitude of 10°, and has been derived by comparing the light of Polaris with that of five different stars at every possible Z.D. between 0° and 80°. For greater Z.D., however, another series has been obtained by observing, on very clear nights, the differences of lustre of objects at their rising or setting up to some 10° of altitude, and deriving from the differences the amount of absorption at the various Z D.s. Such a break in the continuity is perhaps regretable, but to some extent unavoidable. Stars that are visible in the horizon do not reach the zenith of Potsdam within some 15°, and, of course, stars culminating near the zenith do not approach near enough to the horizon. Comparing each part of Müller's general extinction table with Laplace's theory, Dr. Kempf obtains the following result (M.-L.) I.; but, for very sufficient reasons, on discarding the last observation at 80° Z.D., which is evidently discordant, and affects the accuracy of the determination of the general coefficient of transmission, he obtains the second series marked (M.-L.) II., in which the agreement leaves very little to be desired.

Z.D.	(M.-L.) I.	(M.-L.) II.	Z.D.	(M.-L.) I.	(M.-L.) II.
20°	−2	−2	72°·5	+10	+5
40	−3	−4	75	+ 9	+2
50	−2	−3	77·5	+ 1	−7
60	+3	0	80	−17	—
70	+9	+5			

Nearly as satisfactory is the comparison of the theory with the second part of the table, that below 80° Z.D. The greatest deviations, when expressed in magnitude, do not exceed 0·025 m., and any one acquainted with the difficulties attending photometric observations so close to the horizon, will rather be surprised that the agreement is so close, than tempted to cavil over the small discordances. In the first part, the coefficient of transmission is 0·81; in the second, 0·85: the two parts, therefore, correspond to different degrees of atmospheric transparency, and they cannot be represented by one and the same curve. The explanation offered by Dr. Kempf will probably command a general assent, and it will be admitted that he has made out his case, that Laplace's theory of absorption corresponds exactly to the actual conditions within the limits of accuracy at present attainable.

If Dr. Kempf has provided the true explanation, it is of little use to follow Dr. Hausdorff in his further investigations, based as they are on the entire conviction that Müller's extinction table is exact, and that the discordance between theory and observation is real. His attempts to devise new formulæ on various hypotheses are not very satisfactory, simply regarded as interpolation results; and his failure to represent Dr. Müller's figures more closely, tends to confirm the probability of Dr. Kempf's suggestion. Of course, by the extension of formulæ to an inconvenient length, and the introduction of a sufficiently large number of unknowns, derived from the observations themselves, a close agreement can be forced; but even then one may be driven to such inconvenient consequences as that the intensity of light at approximately the sea-level is greater than that at the top of a mountain 2500 m. high. On no supposition (and in some instances the ingenuity displayed in the construction of hypotheses is considerable) can a formula be found that more closely represents observation than does Laplace's; and though the author did not propose to himself to establish this fact, he has rendered no slight service to theoretical photometry by the practical confirmation his work affords.

W. E. PLUMMER.

ON CERTAIN VESTIGIAL CHARACTERS IN MAN.

SEEING that Prof. Huxley, with his well-known candour, felt constrained to admit that the study of rudimentary or vestigial characters had done more than that of any other class of facts to produce general acceptance of the doctrine of evolution, and that at the same time he acknowledged the double-edged

nature of these characters, it is not out of place to appraise the evidential value of certain of them.

The direction of the hair-slope on three regions of the body, as bearing upon the simian ancestry of man, will be first considered.

(1) On the upper extremity of man the direction of the hair-slope, which may for the sake of brevity be called the *Human Type*, is as follows:—On the upper arm the slope is all downwards to the elbow, with a slightly oblique direction on the anterior surface. This direction appears to be the same as that in all the monkeys examined.

But on the fore-arm the *Human Type* is as follows:—On the flexor surface the stream of hair divides and passes obliquely to the radial and ulnar borders respectively, and to the carpus. On the extensor surface the slope continues on the radial side in a direction at right angles to the long axis of the limb, and gradually curls backwards over the posterior surface of the ulna, joining a corresponding "backwash" of the stream of hair from the ulnar border. Thus, on a small area amounting to about a fourth of the extensor surface, the united stream of hair passes directly to the elbow.

This description is based upon the examination of numerous fore-arms, hairy and non-hairy; of infants a few days old and three months old, of children from seven to fourteen years old, of adults male and female—among the adults five very hairy male subjects. In all of these fore-arms, as far as the scanty hair on some would allow one to observe it, there was very little departure from the *Human Type* as described. In the cases of infants, the hairs were very minute and required a lens to reveal them. The direction stated is easy to verify or to disprove; but it is surprising to find such a statement as occurs in "Darwin and after Darwin," by the late Prof. Romanes, where, on page 89, he says, "again, in all men the rudimentary hair on the upper and lower arm is directed towards the elbow—a peculiarity which occurs nowhere else in the animal kingdom, with the exception of the anthropoid apes and a few American monkeys. . . ." With this statement Prof. Romanes and Prof. Drummond seem to have remained satisfied, though their own fore-arms, and those of every person they might have examined, would have told a different tale, either with or without the assistance of a lens. The statement of Prof. Romanes clearly refers to the permanent hair of the body, as shown by his illustrations, and not to the lanugo or temporary hair.

The direction of the hair-slope on the fore-arm of the anthropoid apes—*the Anthropoid Ape Type*—is certainly what is stated by Romanes and Drummond, viz. towards the elbow with a slightly lateral direction both on the flexor and extensor surfaces, except in the orang, in which the slope is all directly to the elbow. This is to be seen in all the anthropoid apes at the Zoological Society's Gardens, London, in the case of the gorilla, chimpanzee, and gibbon hoolock, and in the case of the orang at the Natural History Museum, South Kensington, where also the slope of the hair on the fore-arms of gorilla, chimpanzee, and gibbon is confirmed. St. George Mivart[1] mentions one species of gibbon, *Hylobates agilis*, where the *Human Type* appears to be exceeded in the *wrist-ward* direction. He says, "in *Hylobates agilis* all the hair of both these limb-segments is directed towards the wrist."

This statement is not fully borne out by the examination of the specimens of *Hylobates agilis* at South Kensington.

In addition to these four genera of anthropoid apes, twenty-two other species of monkeys were examined as to the slope of the hair on the fore-arm, with the following results:—

A 19. *Catarhine or Old World monkeys*, as follows:—

13. Human Type, viz.:—
Cercocebus æthiops—Barbary ape—Japanese ape—Cercopithecus campbelli—Cercopithecus ruber—Cercopithecus diana—Cercopithecus callitrichus—Cercopithecus lalandii—Cercopithecus griseo-viridis—Cynocephalus anubis—Macacus maurus—Arabian baboon—Cercopithecus abigulosus.

(1) Anthropoid Ape Type, viz.:—
Cercopithecus cephus.

(5) Partial Human Type inclining to Anthropoid Ape Type, viz.:—
Cynopithecus niger—Cercocebus fuliginosus—Macacus cynomologus—Macacus rhesus—Macacus sinicus.

[1] Encyclop. Brit., vol. ii. p. 157.

B (3) *Platyrhine or New World monkeys.*

(2) Human Type, viz.:—
Cebus fatuellus—Cebus monachus.

(1) Anthropoid Ape Type, viz.:—
Ateles geoffroyi.

Thus of twenty-two lower monkeys, Old World and New World, fifteen very closely resemble the human subject in this small morphological character, whereas all the anthropoid apes (one species of one genus excepted) are markedly different from the *Human Type*.

Such things ought not to be on the theory of the descent of man from the ape. They may not alone support the opposing theory, but they ought never to have found their way into valuable and popular books, being selected from a great array of so-called vestigial characters with a view to supporting the above theory.

(2) There is no reason why the direction of the hair-slope on the fore-arm should be studied in its vestigial character, any more than that on the *thigh*. On the *thigh* the *Human Type* is as follows: On the flexor surface the hair slopes in two streams to the outer and inner borders respectively, and towards the knee. At the upper third and outer side the slope takes a direction at right angles to the long axis. On the extensor surface the streams of hair which come from the borders coalesce and pass to the back of the knee. The Simian Type is oblique, and *to the pelvis*, *i.e.* in the favourite position of the monkey, when sitting on its haunches, the hair falls quite vertically downwards. This statement is based on the observation of the four anthropoid apes and twenty-seven other lower monkeys, including the twenty-two previously specified, thirty-one in all. There were found, out of these thirty-one specimens, ten partial exceptions, five American monkeys, and five lower Old World monkeys, such as baboons, Barbary ape, and Japanese ape. In these ten there was a slight resemblance to the *Human Type*, but not a vestige of resemblance in one of the anthropoid apes examined.

(3) A third region of the human body shows the divergence between the *Human Type* of hair-slope and the *Simian Type* even more strongly. On the dorsal surface of the trunk in man, in the erect posture, the hair slopes in the supra-scapular region inwards and at a right angle to the middle line, on approaching which it curls downwards. Below the spine of the scapula the same direction obtains until about the level of the angle, when the hair slopes *upwards* and inwards to a point over the transverse processes of the vertebræ, where it becomes horizontal and then curls sharply downwards, joins the stream of hair from the opposite side, and passes vertically downwards in the hollow over the vertebral spines. This Human Type I have found constant in children and adults, and it differs strikingly from that of all the apes and monkeys examined, in which, without exception, the hair slopes as nearly as possible vertically downwards, when the animal is sitting.

These remarks, calculated to disparage the value of the direction of the hair-slope on the human body as a "vestige" of his descent from the ape, may be met in two ways at least. In the first place, one may be reminded that it is not to the few existing anthropoid apes, "living fossils," indeed, but to some unknown *dead* fossil apes of the Miocene period that we must look for the direct ancestry of man, and that the difference in the hair-slope pointed out is consequently unimportant. Perhaps it is. But the supposed resemblance was thought worthy of prominence in the works of evolutionists, and accordingly the ascertained divergence is worthy of not less prominence.

In the second place, the differing hair-slope on the *fore-arm*, *thigh*, and *back* of man and the anthropoid apes, may be explained by the possible influence which the greater weight of the long hair covering the bodies of apes would have in producing a *generally vertical direction* of hair-slope in the sitting posture. This posture doubtless is the one in which far the greater part of the life of the ape is spent, and a little consideration of the position of an ape in sitting, will show that gravitation would tend in the case of long-haired apes to produce the *Anthropoid Ape Type* on the fore-arm, thigh, and back. In the case of man, the action of gravity would be unable to influence the slope of his short rudimentary hairs. This suggestion of a possible cause contributing to the hair-slope on the bodies of apes has, however, no bearing on the question of fact. It may be an explanation, but the facts remain.

Thus man in these characters resembles much more closely the lower Cercopithecidæ and Cebidæ than his supposed

nearest congeners, at present existing. It is also incorrect to assert that only in man, a few American monkeys, and the anthropoid apes, does the hair slope towards the elbow. This Human Type is seen in the corresponding area of this segment of the anterior extremity of almost all hairy mammals, excepting most of the Ungulate types, and those with woolly hair. It is found very constantly in Carnivores, especially those which frequently rest in a "couchant" attitude, in which the head is held erect, the fore-limbs planted in front of the body, and the extensor surface of this limb-segment resting flat on the ground, also in certain other positions of rest; and it can be seen in nearly all wild Carnivores and domestic cats and dogs. In those Carnivores which assume this attitude the posterior limbs adopt a much more variable "pose," and here there is no constant form of hair-slope. The backward curl of hair on this narrow area of the fore-arm in man, certain monkeys, and many other hairy mammals, seems to be due to a mechanical force, slowly acting downwards and forwards, which makes for this direction of hair-slope. In all these three classes it is obvious that such pressure is frequent. This explanation of an inherited character, maintained by a simple physical cause, meets the case far better, I submit, than any supposed tracing out of ancestral vestiges. WALTER KIDD.

IS ANIMAL LIFE POSSIBLE IN THE ABSENCE OF BACTERIA?

SOME ten years ago Pasteur, in one of those "causeries du laboratoire" which those who were privileged to take part in will never forget, discussed with the young scientific men around him the interest which would attach to the nourishment of an animal from its earliest existence with sterilised food under conditions which would ensure the absence of all microbial life. "Sans vouloir rien affirmer," he added, "je ne cache pas que j'entreprendrais cette étude, si j'en avais le temps, avec la pensée préconçue que la vie dans ses conditions deviendrait impossible. . . . Que le résultat soit positif et confirme la vue préconçue que je mets en avant ou qu'il soit négatif et même en sens inverse, c'est-à-dire que la vie soit plus facile et plus active, il y aurait un grand intérêt à tenter l'expérience."

To decide this question Messrs. George Nuttall and H. Thierfelder have carried out elaborate experiments in the Hygienic Institute of the Berlin University with young guinea-pigs removed from the mother by means of the Cæsarean operation. Every conceivable precaution was taken to prevent all access of bacterial life. The young guinea-pig was placed in a sterilised chamber, supplied with sterilised air, and it was fed exclusively upon sterilised milk. It had to be supplied with food every hour, day and night, a process which so exhausted the investigators that at the end of eight days, when it had consumed 330 cubic centimetres of milk, and to all appearances was in perfect health and spirits, it was killed.

A microscopic examination of the contents of the alimentary canal revealed no bacteria whatever; ærobic and anærobic cultures in various media were further made of the intestinal contents and of the excreta, but in every case the culture tubes remained sterile, not a single colony made its appearance. Messrs. Nuttall and Thierfelder claim by these experiments to have proved conclusively that the presence of bacteria in the alimentary canal is not essential to vital processes, at any rate in the case of guinea-pigs; and they consider themselves justified in assuming that other animals, and also human beings, could similarly exist in the absence of bacterial life, as long as the food supplied is purely animal in character. Whether the conditions would be altered by the addition of *vegetable* food to the diet, they next endeavoured to determine. In this series of experiments the food selected was so-called "English" biscuits containing about 7 per cent. nitrogenous material, 9 per cent. fat, 17 per cent. sugar, 58 per cent. of other non-nitrogenous matters, and 0·2 per cent. cellulose; these, together with the milk employed, were sterilised before use. The same rigorous precautions characterised these experiments as the previous ones; more animals were, however, secured, and they were allowed to live longer. The weight of the animals was this time carefully noted, and during the ten days, during which the experiment lasted, one animal gained 23 grammes and another 11 grammes. This calculation could only be an approximate one, as the experimental animals were not weighed when originally removed from the mother, and their initial weight was only arrived at by weighing the other guinea-pigs which were removed at the same time, but not experimented upon. Thus in the case of vegetable substances bacterial life is apparently also not essential for carrying on digestive processes. The authors made also as careful an examination as was possible with the limited amount of material at their disposal, of the urine, and state that aromatic oxyacids were undoubtedly present. This result they regard as confirmatory of E. Baumann's assertion that aromatic oxyacids may be elaborated independently of intestinal decomposition. To this point they intend, however, to return later; at present further investigations are in progress with fowls, and the results will be awaited with the greatest interest, while immense credit is due to the authors for the ingenuity of the methods they have devised, and the self-sacrificing laboriousness with which they have conducted the experiments.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, Dec. 21, 1896.—Lord Kelvin in the chair.—The first paper, on atomic configurations in molecules of gases according to Boscovich, was by the President himself. At the outset Lord Kelvin confessed that the problem was quite beyond him, and he only desired to throw out some suggestions. Boscovich's theory would quite well explain the atomic configuration of a gas if we could only apply it. In a monatomic gas the problem was fairly easy, collision between molecules leading to change in direction, either backwards on the original path, or at an angle, according as the impact was direct or oblique. For a diatomic gas we must imagine a "pair of somethings" held together by a mutual force which knocked about like one. He thought he could see why a diatomic gas should become monatomic when its temperature was sufficiently raised. But he could not yet understand why, when the process was reversed, molecules should combine in quartettes rather than in pairs, or triplets, and he illustrated his conjectures by means of models. He showed by means of these how, for example, the mutual repulsion between the H's might prevent O from combining with any more than two, and hence we did not have H_3O. And he explained, similarly, how O_3 was unstable, as the octohedral arrangement of the atoms (taking $O = O_2$) was easily broken up. But the whole subject was one of tremendous difficulty.—In an abstract from a paper on the cæcal fossæ, Dr. Richard Berry pointed out that the pericæcal folds and the resulting fossæ were primary in origin, and vascular in evolution. He strongly dissented from Treves' view that the meso-appendix is a substituted mesentery, maintaining that the ilio-colic and ilio-cæcal folds were the true cæcal mesenteries, primary and subsidiary respectively, the meso-appendix being the true appendicular mesentery. Arguing from this and other facts which he adduced, Dr. Berry stated that it would almost appear as though the appendix were gradually replacing the cæcum in functional activity. Passing on to the retro-cæcal fossæ, he pointed out the inaccuracy of the term retro-cæcal as applied to these fossæ, suggesting for them the name retro-colic as being more accurate and more scientific. He proceeded to show that these fossæ were secondary in origin and depended for that origin upon the secondary coalescence, sometimes wanting, of the colon, cæcum, and mesentery, to the posterior abdominal wall. In this respect Dr. Berry differed from almost every British author. He pointed out the variability of these fossæ in number and position, and strongly emphasised their importance to the surgeon in view of the prevalence of appendicitis and the part which these fossæ, according to the author, play in the etiology of that disease.—Dr. T. H. Milroy read a paper dealing with research into the nature of the nucleins and paranucleins of the animal cell. During the last few years much attention has been paid to two great classes of proteids intimately connected with the life of the cell, viz. the nucleins and paranucleins. The former class has been rather vaguely defined as including proteids which have only two points in common—a high percentage of phosphorus in organic combination, and a marked resistance to the action of the gastric secretion. The natural nucleins examined were those of the thymus gland of calves, of the red blood-corpuscles of birds, and of the pancreas of the ox; and these were found to agree in almost every particular with artificial syntonin-nuclein. That is, they were only slowly dissolved, not decomposed by the gastric juice (with the exception of the pancreas nuclein), while trypsin and sodium

carbonate rapidly split them up, the phosphorus passing into solution in organic combination. This phosphorus-holding body is acid in nature, and possesses marked proteid-precipitating properties. It does not seem to be either nucleic or metaphosphoric acid. It was not present in the products obtained from tryptic digestion of the nucleins of the red blood-corpuscles of birds. The combination between paranucleic acid and albumin in ovovitellin is not a firm one, as the acid is easily obtained by the action of weak alkaline solutions upon the mother substance. The acid so obtained is not impure nucleic acid, as Altmann thought, because no nuclein bases appear among its decomposition products. It is very soluble even in cold water, and the solutions so obtained precipitate albumins, &c., out of their solutions. It gives a distinct Buiret reaction but no red colour with Milton's reagent. It does not give any precipitate with ferrocyanide of potassium and acetic acid. It contains, on an average, about 7·8 per cent. phosphorus. From the nucleic acid of the thymus another acid can easily be obtained which still retains the proteid-precipitating power of the original acid, but no longer gives, on decomposition, nuclein bases, agreeing in these particulars with the paranucleic acid of the paranucleins. These point at least to means by which the nuclein series of proteids may be built up and decomposed in the animal organism.—A paper by Dr. Thomas Muir, on the expression of any bordered skew determinant as the sum of products of Pfaffians, was taken as read.—Lord Kelvin then, by permission of the Council, gave an extra paper describing the result of experiments conducted by him along with Drs. Beattie and Smolan as to the effect of Röntgen rays on air (see p. 199).

PARIS

Academy of Sciences, December 28, 1896.—M. A. Cornu in the chair.—On the method of Bruns, by M. Poincaré. An account of an exception to Bruns' theorem, and an amendment to part of his proof.—A new theory of cicatrisation, and on the part played by the anterior epithelium of the cornea in the healing of wounds in this membrane, by M. L. Ranvier. Observations showing that cellular multiplication is not indispensable to the formation of a cicatrix, and that this multiplication, when it occurs, is of only secondary importance in the process of healing.—New note on the application of radioscopy to the diagnosis of diseases of the thorax, by M. Ch. Bouchard. Several cases of diseases of the thorax were clearly made out by the use of the Röntgen rays with fluorescent screen, but a study of diseases of the abdomen has given much less satisfactory results.—The energy consumed by a muscle in static contraction sustaining a load, studied by means of the respiratory exchanges, by MM. A. Chauveau and J. Tissot.—On the fossil hippopotami of Algeria, by M. A. Pomel. Some remarks on a monograph submitted by the author on the quaternary fossil hippopotami of Algeria.—New nebulæ, discovered at the Observatory of Paris, by M. G. Bigourdan. The positions are given of nebulæ numbered 245 to 281.—On the transformations of differential systems, by M. Etienne Delassus.—On a series relating to the theory of linear differential equations with periodic coefficients, by M. A. Liapounoff.—On the movement of a solid in an indefinite liquid, by M. W. Stekloff.—On the use of a system of numbered points in the representation of equations, by M. M. d'Ocagne.—On a thermic machine, by M. Delsol. An account of the theory of a machine designed to utilise the work done by the gas given off on heating a solution of ammonia.—On the problem of vibrating membranes, by M. Le Roy.—Methods of calculation in electromagnetism, by M. Vaschy.—Effect of the state of the polar surfaces of an exciter on the explosive potentials, static and dynamic, by M. Swyngedauw.—Action of the X-rays on gaseous dielectrics, by M. L. Benoist. It is shown that the law recently found experimentally by M. Jean Perrin, is really identical with that previously enunciated by MM. Benoist and Hurmuzescu.—New facts in the application of radioscopy to intrathoracic lesions, by M. J. Bergonié. The outline of the shadow cast by tubercular lesions was traced out in pencil on the body, with the aid of the fluorescent screen. The line thus drawn was found to coincide with remarkable precision with that previously marked out after a careful study by auscultation and percussion.—On a Crookes' tube for use with alternating current dynamos, by MM. Oudin and Barthélemy.—The Hall-phenomenon in liquids, by M. H. Bagard. A reply to the criticism of M. Floris.—Action of lithium upon carbon and some carbon compounds, by M. Guntz. When lithium, contained in a carbon boat, is heated in nitrogen gas, the boat is attacked, lithium carbide and cyanide being formed. Lithium carbide alone is produced if the heating is performed in a vacuum. The same substance is found among the products of the action of CO and CO_2 upon heated lithium. At 700°, ethylene is completely absorbed by the metal, with the formation of a mixture of lithium carbide and hydride. Acetylene behaves similarly. Methane is only very slightly attacked by lithium at a red heat.—On cyanuric chloride, by M. Paul Lemoult. A thermo-chemical study of the chloride $C_3N_3Cl_3$.—Action of carbonic acid of waters on iron, by M. P. Petit.—The action exerted on solutions of haloid alkaline salts by the corresponding haloid acid, by M. A. Ditte.—On the action of phosphorus on platinum, by M. A. Granger. At very high temperatures, the phosphide obtained appears to be Pt_2P, at lower temperatures using platinum black a phosphide is obtained from which aqua regia extracts Pt_3P_5.—Action of hydrogen chloride in the gaseous state upon alkaline sulphates, by M. Albert Colson.—The reduction of wolfram by carbon in the electric furnace, by M. Ed. Defacqz. The metal produced contained 92·5 per cent. of tungsten, 50 per cent. of carbon, and traces of iron and other metals.—New examples of normal rotatory dispersion, by MM. Ph. A. Guye and P. A. Melikian.—On the transformation of the sulphonated camphophenols into dinitro-orthocresol, by M. P. Cazeneuve.—On hexadiinediol, by M. R. Lespieau. Propargyl alcohol is converted into its cuprous compound by shaking with ammoniacal cuprous chloride, and this oxidised with potassium ferricyanide gives the alcohol, $CH_2.OH-C{\equiv}C-C{\equiv}C-CH_2.OH$.—Contribution to the study of borneols and their ethers, by M. J. Minguin.—The freezing point of milk; reply to a note by MM. Bordas and Génin, by M. J. Winter.—Optical analysis of urine and the exact estimation of the proteids, glucosides, and non-fermentable saccharoid substances, by M. Frédéric Landolph.—General observations on wheat, by M. Balland.—Immunising properties of the serum of the eel against snake venom, by M. C. Phisalix.—On the morphology of *Cryptococcus guttulatus*, by MM. J. Kunstler and P. Busquet.—The regeneration of the vesical epithelium, by M. Etienne de Rouville.—On the presence of an oxydase in the branchia, palps, and blood of the Acephala, by MM. Pieri and Portier.—Parasitism and evolution of two Monstrillidæ in the interior of the vascular system of the Filigranæ and Salmacynæ, by M. A. Malaquin.—New mosasauria found in France, by M. Armand Thévenin. The fossil described was found in the grey phosphatic chalk beds in the north of France, and appears to be the skull of a reptile closely allied to *Mosasaurus giganteus* (Moestricht). The teeth, however, show differences, and the name *Mosasaurus Gaudryi* is given to the species. Another skull found appears to be allied to the American species *Platecarpus*, and the name *Platecarpus Somenensis* is proposed for it.—On the structure of the fundamental protoplasm in a species of *Mortierella*, by M. L. Matruchot.—A new micrococcus of the potato, by M. E. Roze.—Synthesis of hauksite, by M. A. de Schulten. The hexagonal crystals of $4Na_2SO_4.Na_2CO_3$, obtained by pouring a hot solution of sodium sulphate and carbonate into a strong solution of caustic soda, possess the composition and properties of natural hauksite.—Observations on some asphaltic rocks and on the origin of asphalte, by M. Stanislas Meunier. The conclusion is drawn from the behaviour of bituminous rocks towards solvents, that bitumen is the result of purely mineral reactions, of the type of the double decomposition between metallic carbides and water.—On the identity of the phosphates from the Paris and London basins, and on the Tertiary age of this deposit, by M. N. de Mercey.—Documents serving for the geological study of the neighbourhood of Luang Prabang (Cochin China), by M. Counillon.—On the Foiba of Pisino (Istria), by M. E. A. Martel.

NEW SOUTH WALES.

Linnean Society, November 25, 1896.—The President, Mr. Henry Deane, in the chair.—On the comparative anatomy of the organ of Jacobson in Marsupials, by Dr. R. Broom.—Observations on the eucalypts of New South Wales, Part ii., by Henry Deane and J. H. Maiden.—On a new species of *Macadamia*; together with notes on two plants new to the colony, by J. H. Maiden and E. Betche. (*a*) *Macadamia integrifolia*, n.sp., is a small tree originally found near Camden Haven, N.S.W., now under cultivation in the Botanic Gardens, Sydney. It is very closely allied to the well-known Queensland nut, *M. ternifolia* (also found in N.S.W.), from which it may be readily distinguished by the petiolate entire leaves, rather smaller fruits,

and less hairy flowers and inflorescence. (*b*) *Cheirostylis grandiflorus*, Blume, found "in moist forests between rocks on the coast of New Guinea," is now recorded from similar situations near Lismore, Richmond River, N.S.W. Its discovery adds a genus to the flora of Australia. (*c*) *Grevillea alpina*, Lindl., hitherto only recorded from Victoria, has been found in the Albury district.—On a new fungus (*Capnodium callitris*) attacking the Murray pine; together with observations on a fungus found on *Hypocræris radicata*, L., by D. McAlpine.—On some Australian gudgeons (*Eleotridinæ*), by J. Douglas Ogilby.—Descriptions of some new *Araneidæ* of New South Wales, No. 7, by W. J. Rainbow.—Contributions to a knowledge of the arachnidan fauna of Australia, No. 1, by W. J. Rainbow. This paper, the first of a new series, is descriptive of a new scorpion (*Buthus flavicruris*) from Como, obtained by Mr. J. D. Ogilby.—On Domatia in certain Australian and other plants, by Alex. G. Hamilton.—Description of a new species of Pupina from Queensland, by C. E. Beddome.—Revision of the genus *Paropsis*, Part i., by Rev. T. Blackburn.—The Silurian trilobites of New South Wales, with references to those of other parts of Australia. Part iv. The *Odontopleuridæ*, by R. Etheridge, jun., and John Mitchell.—Note on a Papuan throwing-stick, by J. Jennings.—On the so-called evidences of glaciation on the Mt. Kosciusko plateau, by Rev. J. Milne Curran. The author concluded that (1) there is no satisfactory evidence of glaciers in the present valleys. (2) There is absolutely no evidence of extensive glaciation on the Kosciusko plateau. (3) The "glacial epoch in Australia" in Post-Tertiary times as described by Dr. Lindenfeld, has no foundation in fact.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 7.

ROYAL INSTITUTION, at 3.—Visible and Invisible Light: Prof. S. P. Thompson, F.R.S.

FRIDAY, JANUARY 8.

ROYAL ASTRONOMICAL SOCIETY, at 8.—A Method of Clearing a Lunar Distance: F. C. Penrose.—Determination of the Diameter and Compression of the Planet Mars, from Observations with the Repsold Heliometer of the Royal Observatory, Göttingen: W. Schur.—On the Comparison of Reflector and Portrait Lens Photographs: Dr. Isaac Roberts.—Note on the Magnitude of η Argûs, 1896: R. T. A. Innes.—Orbit of 44 Boötis ⫷ I. 15 = Sh. 193 = Σ 1909: S. W. Burnham.

SATURDAY, JANUARY 9.

ROYAL INSTITUTION, at 3.—Visible and Invisible Light: Prof. S. P. Thompson, F.R.S.

SUNDAY, JANUARY 10.

SUNDAY LECTURE SOCIETY, at 4.—Artificial Light: Prof. Vivian B. Lewes.

TUESDAY, JANUARY 12.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Superheated Steam-Engine Trials: Prof. W. Ripper.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photography by the Röntgen Rays, up to date: Dr. Hall-Edwards.

WEDNESDAY, JANUARY 13.

SOCIETY OF PUBLIC ANALYSTS, at 5.—Annual Meeting.—Also, some Analyses of Water from an Oyster Fishery; Note on Weighing out Fats; Remarks on Formaldehyde: Chas. E. Cassal.—A Specific Gravity Pipette: W. F. Keating Stock.—A Modified Schmidt Process: R. W. Woosnam.

THURSDAY, JANUARY 14.

MATHEMATICAL SOCIETY, at 8.—Supplementary Note on Matrices: J. Brill.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address of the President, Sir Henry Mance.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY.—Some Marine Mimics: E. Step.

FRIDAY, JANUARY 15.

EPIDEMIOLOGICAL SOCIETY, at 8.—Age Incidence in Relation with Cycles of Disease Prevalence: Dr. Hamer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On "Monier" Girders and Arches: Walter Beer.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Register of the Associates and Old Students of the Royal College of Chemistry, &c.: T. G. Chambers (Hazell).—Œuvres Scientifiques de L. Lorenz, Revues et Annotées par H Valentiner, Tome 1, Fasc. 1 (Copenhague, Lehmann).—A Handbook to the Game Birds: W. R. Ogilvie-Grant, Vol. 2 (Allen).—Microscopic Researches on the Formative Property of Glycogen: Dr. C. Creighton. Part 1. Physiological (Black).—Coloured Figures of the Eggs of British Birds, with Descriptive Notices: H. Seebohm, edited by Dr. R. B. Sharpe (Sheffield, Pawson).—The Collected Mathematical Papers of Arthur Cayley, Vol. xi. (Cambridge University Press).—The Constitution and Functions of Gases, &c.: S. J. Corrigan (St. Paul, Pioneer Press Company).—Untersuchungen über Bau, Kernteilung und Bewegung der Diatomeen: R. Lauterborn (Leipzig, Engelmann).—Smithsonian Institution Report to July 1894 (Washington).—Notes of Lessons on Elementary Botany: W. Bland, 12th edition (Bemrose).—Outlines of Psychology: W. Wundt, translated by C. H. Judd (Williams and Norgate).—A Dictionary of Birds: A Newton and others, Part 4 (Black).—Catalogue of the African Plants collected by Dr. F. Welwitsch in 1853-61. Dicotyledons, Part 1: W. P. Hiern (London, British Museum, Natural History).—Inorganic Chemical Preparations: Dr. F. H. Thorp (Boston, Ginn).—Oceanic Ichthyology: Drs. G. B. Goode and T. H. Bean, Text and Plates (Washington).—Life Histories of North American Birds: Captain C. Bendire (Washington).—A Catalogue of 16,748 Southern Stars deduced by the U.S. Naval Observatory from the Zone Observations made at Santiago de Chile (Washington).—Sixteenth Annual Report of the U.S. Geological Survey, Part 1 (Washington).—Annals of the Royal Botanic Garden, Calcutta, Vol. v. Part 2; Vol. vi. Part 1; and Vol. vii. (Calcutta, Bengal Secretariat Press).

PAMPHLETS.—Annuaire Astronomique et Météorologique pour 1897: C. Flammarion (Paris, E. Flammarion).—An Account of the Crustacea of Norway, Vol. 2, Parts 1 and 2: G. O. Sars (Bergen).—Annuaire de L'Académie Royale des Sciences, &c., de Belgique, 1897 (Bruxelles).—The Camera and the Pen: T. C. Hepworth (Lund).—Museums Association Report (Dulau).—Meteorological Observations and Results obtained at the U.S. Naval Observatory for the Year 1890 (Washington).

SERIALS.—History of Mankind: F. Ratzel, translated, Part 15 (Macmillan).—Lloyd's Natural History. Game Birds, Part 3: W. R. Ogilvie-Grant (Lloyd).—Lloyd's Natural History. British Birds, Part 7: R. B. Sharpe (Lloyd).—Longman's Magazine, January (Longmans).—Century Magazine, January (Macmillan).—Notes from the Leyden Museum, Vol. xviii. Nos 2 and 3 (Leyden, Brill).—Economic Journal, December (Macmillan).—Bibliographia Physiologica, 1896: Prof. Ch. Richet, Premier Fasc. (Paris, Alcan).—Zeitschrift für Physikalische Chemie, xxi. Band, 3 Heft (Leipzig, Engelmann).—National Review, January (Arnold).—Contemporary Review, January (Isbister).—Natural Science, January (Page).—Science Progress, January (Scientific Press).—Reliquary and Illustrated Archæologist, January (Bemrose).—Astrophysical Journal, December (Chicago).—Fortnightly Review, January (Chapman).—Humanitarian, January (Hutchinson).—Scribner's Magazine, January (Low).—Bibliography of the more important Contributions to American Economic Entomology, Part 5 (Washington).—Journal of the Chemical Society, December (Gurney).—Journal of the Royal Agricultural Society of England, December (Murray).—Geographical Journal, January (Stanford).—American Journal of Psychology, Vol. viii. No. 2 (Worcester, Mass.).—Internationales Archiv. für Ethnographie, Band ix. Heft 6 (Leyden, Brill).

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