THURSDAY, JUNE 8, 1899.

MAN, PAST AND PRESENT.

Man, Past and Present. By A. H. Keane. "Cambridge Geographical Series." Pp. xii + 548, illustrated. (Cambridge University Press, 1899.)

A TRUSTWORTHY and up-to-date work in a small compass on "Ethnology" in its wider sense, in which the human race should be considered in greater detail from a zoological (anthropological) rather than from a linguistic and cultural (ethnological) point of view, was a decided want in this country. And this want has been well supplied by the volume before us, with its precursor in the same series published three years ago under the title of "Ethnology." It is, however, in our opinion, a matter for distinct regret that the author and the editor did not at first starting definitely make up their minds as to the extent to which the subject of ethnology (again using the term in its wider sense) was to figure in the series. Had this been done, a considerable amount of useless and irritating repetition might have been avoided, while the present volume would have been much more fully illustrated.

According to the present arrangement, the second part of the "Ethnology" treats of the primary divisions of mankind, of which the author recognises four; and in each of these divisions the chief groups or sections are described in more or less detail. In the present volume, on the other hand, attention is directed to the detailed classification of the various groups and races of the four main divisions. It would have been far preferable had the descriptions of the main divisions given in the first volume been immediately followed by the detailed history of the race-groups which appears in the second, with a blending of some of the matter relating to these latter from the "Ethnology," and the omission of the rest. The numerous excellent illustrations of racial types in the first volume would then have been available for the detailed descriptions in the second, where they are now so sorely needed. To illustrate what we mean, we may refer to the notices of the Andamanese on p. 256 of the first, and p. 158 of the second volume. In both instances we are informed that these people were miscalled "Mincopies," in both that their language is unlike any other, and in both that their numerals only extend to two, but that ten can be counted by means of the fingers. Again, if the accounts of the Bushmen and Hottentots on pp. 248 and 250 of the first, and p. 121 of the second volume be compared, it will be found that while there is a certain amount of repetition; neither is complete without the other, so that a judicious blending is clearly required.

But this is not quite all the fault we have to find with the general plan adopted by the author, who, we venture to suggest, would be all the better for a little training in descriptive zoology. For instance, in neither volume do we find a definite description of the characters of the Negroid division ("*Homo aethiopicus*"), as distinct from all other divisions; although in the one under consideration we have many such division-characters given as distinctive of a minor group, to wit, the Sudani negroes. Still more pronounced is this confusion in the case of the Mongoloids ("*Homo mongolicus*"), of which the division-characters are correctly given on p. 297 of the first volume, only to be repeated as group-distinctions on pp. 169 and 170 of the second. And here it may be mentioned that, since the author insists very strongly on the specific unity of mankind, he has no justification for using the names above referred to. The proper terms should, of course, be *Homo sapiens aethiopicus* and *H. s. mongolicus*.

In his treatment of the four main divisions of mankind in the present volume, the author commences with the Negroid; and his clear account of the essential difference between the Sudani and Bantu sections of African Negroes affords an important contribution to a very difficult subject, in which a considerable amount of new matter appears. It is, however, a matter for regret that the author has seen fit to discard M. Hamy's convenient term "Negrillos" for the dwarf races of equatorial Africa, since if they are called Negritos, it is liable to lead to confusion with the Andamanese and other Oceanic Negroid races. In treating of the southern Bantu, the author draws attention to the fact that the term Kaffir is only a corruption of the name Kafir applied indiscriminately by Muhammedans to all unbelievers, as exemplified by the Siahposh Kafirs of Central Asia. He consequently suggests the substitution of "Zulu-Xosas" for Zulus and Kaffirs; but unless, which is extremely unlikely, this meets with popular acceptation, the proposed change does not seem advantageous. Mr. Keane fully supports Sir Harry Johnston's estimate of the non-progressive nature of the Negro character (even in its Bantu modification); and he accordingly agrees with Mr. Bent in regarding the Zimbabwe ruins as of Arabic origin.

In the classification of the oceanic members of the Negroid group, the author follows the generally received views. He, however, considers that the Papuans, although nearly allied to Melanesians, should not be merged in the latter, and therefore proposes the term Papuasians for the two. On p. 145 he states that

"the ethnological parting-line between the Malayan and Papuasian races, as first laid down by Wallace, nearly coincides with his division between the Indo-Malayan and Austro-Malayan floras and faunas, the chief differences being the position of Sumbawa and Celebes. Both of these islands are excluded from the Papuasian realm, but included in the Austro-Malayan zoological and botanical regions."

In this connection it is unfortunate that Mr. Keane does not appear to have seen certain recent works, in which the right of Celebes to be included in the Orienta region is very strongly urged. Had he done so, he would have been able to point out an interesting coincidence between ethnographic and zoological boundaries.

Evidence in favour of another such coincidence is noticeable in the author's contention that Tibet is the cradle of the Mongol division of mankind, the mammals of that plateau being, as is well known, curiously different from those of adjacent districts. As Tibet slowly rose from a lower elevation in Pleistocene times, so, if we understand the author rightly, the Mongols gradually became differentiated from a more generalised human stock, subsequently to descend and pour over the lowlands to the south.

It seems partly due to this hypothesis that the author is strongly in favour of regarding the native races of America as entitled to form a distinct primary division of mankind, and not a part of the Mongoloid. He states, however ("Ethnology," p. 336), that "the American undoubtedly approximates nearest to the Mongol form, and as the latter cannot be derived from the former, it follows, as is now generally allowed, that the American type has been differentiated from a generalised Mongol prototype." This is really a distinction without a difference; and as we scarcely suppose that any anthropologist would derive Americans from the typical Mongol as we know him now, there seems little reason for departing from the view that the former are a branch of the Mongoloid division.

Even, however, in his own view, the author does not appear quite logical, for, after speaking of the above-mentioned close relationship of Americans and Mongols, on p. 353 of the present volume, he seeks to connect the Eskimo with the long-headed palæolithic man of Europe. Now, Sir William Flower, in his address to the Anthropological Institute in 1885, stated that "such scanty remains as have yet been discovered of the early inhabitants of Europe present no structural affinities to the Eskimo, although it is not unlikely that similar external conditions may have led them to adopt similar modes of life." This very definite statement requires refutation before the opposite view can be maintained; and then it has to be shown that the palæolithic long-head approximated to a Mongoloid type. Moreover, if he should be so proved, then he must apparently have been near to, if not the actual progenitor of, the typical Tibetan Mongol; and if so, how can the Eskimo and the Mongol be genetically separated?

In one other important point Mr. Keane also departs widely from the classification adopted by Sir William Flower. This is in regard to the peoples commonly called Polynesians, or Eastern Polynesians. These, which include the Samoans, Maori, Tongans, Tahitians, Marquesas Islanders, and Hawaians, together with some of the Fijians, are regarded by Sir William as an offshoot from the Mongolian stock, displaying evidence of a Melanesian crossing. Their resemblance to the Caucasic type has, writes Sir William,

"led some writers to infer a real extension of the Caucasian element at some very early period into the Pacific Islands, and to look upon their inhabitants as the product of a mingling of all three great types of men. Though this is a very plausible theory, it rests on little actual proof, as the combination of Mongolo-Malayan and Melanesian characters in different degrees, together with the local variations certain to arise in communities so isolated from each other and exposed to such varied conditions as the inhabitants of the Pacific Islands, would probably account for all the modifications observed among them."

This "very plausible theory" is adopted in its entirety by Mr. Keane; and, under the name of "Indonesians," we find the Polynesians on p. 562 of the volume before us definitely taking their place in the Caucasian division; the remark being added, that "their claim to belong to this connection can no longer be seriously questioned." In view of the passage quoted above, this statement appears to us decidedly too positive to be employed in a controversial case of this description. It is noteworthy that in the "Ethnology" these same "Indonesians," though considered of Caucasian origin, are still retained in the chapter devoted to Mongolians.

It may be added that in both volumes the amount of space devoted to the Polynesians is far too short, the Maori especially having only a very few lines assigned to them. Little is also said with regard to the Melanesians of Fiji; and we have been unable to discover a reference to the remarkable dolichocephalic development of the Kai Colo mountain tribes of those islands.

Further criticism is prevented by lack of space. We may accordingly conclude by the expression of our sense of the high value of Mr. Keane's work, which will be acceptable alike to the advanced student of ethnology and to all those interested in the natural history of their own race. The issue of a second edition of the "Ethnology" sufficiently vouches for the popularity of that volume. Should a new edition of both volumes be called for, we venture to think that if the author could see his way to combine and amalgamate them on the lines suggested above, a very admirable work would be presented in a form more convenient for general reference.

R. L.

PRACTICAL GEOMETRY.

Text-book of Practical Solid Geometry, &c., for the use of the Royal Military Academy, Woolwich. By Captain E. H. de V. Atkinson, R.E. Pp. 116 + xvi plates. (London: E. and F. N. Spon, Ltd., 1899.)

Geometrical Drawing for Army and Navy Candidates and Public School Classes. By E. C. Plant, C.B. Vol. I. Practical Plane Geometry. Pp. xiv + 186. (London: Macmillan and Co., Ltd., 1899.)

THE characteristic deficiencies of English text-books are painfully conspicuous in most of the current works on practical geometry. Take a second-rate cookery-book, and shuffle the recipes at random; you will have a fair analogy to the quality and sequence of the books provided for the Army cadet or the Science and Art candidate. Assuredly they manage these things better in France. A century ago, Monge expounded the principles of the method of plan and elevation (*géométrie descriptive* as he called it) with a simplicity, clearness and order which have never been surpassed, although, no doubt, improvements in detail have been effected. The school which Monge created followed loyally in the steps of their master; and the consequence is that in France a student of civil or military engineering can attend a course or study a treatise on descriptive geometry which makes him familiar with a *method*, a system of elementary principles which he can apply to an endless variety of practical problems.

"Monge a souvent répété que, lorsqu'on savait les divers problèmes relatifs au point, à la droite et au plan, et dont l'ensemble forme ce que l'on appelle encore et assez improprement *les préliminaires de la géométrie descriptive*, on savait la géométrie descriptive."

So says Olivier in the preface to his excellent course published in 1843-4, and based upon lectures actually delivered in the École Centrale des Arts et Manufactures.

Accordingly, after a brief introduction, M. Olivier discusses the representation of the point, the straight line, and the plane, and the elementary problems relating to them. What is offered instead of this to the English student? Rules for finding the plan and elevation of an equilateral triangle, of a cube, octahedron, &c., in various specified positions, with a very few really fundamental problems apologetically inserted here and there. Now although the representation of a few concrete solids may be useful to help the beginner to see the object of orthogonal projection, a text-book wholly, or almost wholly, devoted to such special problems is of very little use, except for the passing of examinations set exclusively on these lines.

Similar remarks might be justly applied to most of our books on practical plane geometry and perspective. The almost invariable rule is to give a more or less numerous set of isolated examples, all worked out, with as little discussion of principles as possible: the result is that the student, instead of being provided with a powerful instrument capable of endless adaptation, is merely acquainted with a bundle of dry practical rules.

The works which have suggested these observations are by no means the worst of their class: on the contrary, they are much better than the average, and mark, it is to be hoped, a movement in the direction of reform.

Captain Atkinson's book is intended chiefly for the Royal Military Academy, and its scope has doubtless been dictated by this consideration. Its principal merit is that it contains three chapters on horizontal projection (*i.e.* the method of an indexed plan) which really do give a useful and practical outline of this method in an orderly way. Most of the elementary problems are solved, and the examples appear to be well chosen. It would have been a good plan to give the data of some unworked problems graphically instead of stating them all in words. The earlier part of the book is less attractive; it contains a bare outline of orthogonal projection and a few miscellaneous notes on regular solids, ways of drawing an ellipse, &c. The book ends with a sketch of the method of isometric projection. The plates are clear: unfortunately they are printed on folded sheets, and bound up at the end of the book; this makes it very difficult to follow a figure and the text relating to it simultaneously. If the plates were bound separately the convenience of the work would be greatly increased.

Mr. Plant discusses a great variety of problems, which have been arranged in groups in a fairly systematic way. The figures are from photographs of actual drawings by the author and his assistants, and so afford the student a real practical standard of accuracy. The book is likely to be very useful to the classes for whom it is intended: at the same time, there are several points on which it appears to us rather open to criticism.

In the first place, the attention given to different groups of problems is not proportional to their importance. At least half of the problems in sections G to K might have been set as exercises; this would have given space for a discussion of similar figures—an important subject almost ignored.

Again, the use of set squares for drawing parallels receives no attention, although these instruments are casually mentioned in the introduction. Nothing is more essential to the draftsman than familiarity with the use of set squares; compass constructions (such as those given in this book) for drawing parallels and perpendiculars are seldom used in practical work.

In a similar way, the use of the protractor for setting off angles is not sufficiently brought out. There is actually a section on the construction of certain special angles (such as 67° 30′) without a protractor. The section on regular polygons is specially unsatisfactory: there may be some sense in giving an accurate compass construction for a pentagon, but what earthly use is there in giving *incorrect* constructions (*e.g.* for the heptagon, p. 30 and elsewhere) which only afford an approximation obtainable much more simply by means of a protractor or scale of chords, or even by a method of trial? It may be added that these approximate constructions are given without any warning of their real inaccuracy.

Finally, there are a good many examples of no practical importance: for instance, group J is "To inscribe a square in all (!) the figures capable of containing it." Of course when questions of this kind turn up as Euclid riders, it is a good thing to make a schoolboy draw an accurate figure; but to include them in a text-book of practical geometry is waste of space.

The fact is that ideal treatises on practical geometry in all its branches, for the use of English students, have yet to be written. Ordinary plane geometry, orthogonal projection, perspective and projective geometry—all these are methods of extreme value, both to the mathematician and to the engineer, when they are really mastered; but a mere smattering is of very little use. Unless you know thoroughly the elementary principles involved, the solution of hundreds of isolated examples is little better than waste of time: here, as elsewhere, an ounce of theory is worth a ton of "practice" of the usual kind. Real practice, of course, is indispensable; but it should be systematic, and illustrate principles of general application. G. B. M.

OUR BOOK SHELF.

Michael Faraday: His Life and Work. By Silvanus P. Thompson, D.Sc., F.R.S. Pp. ix + 308. "The Century Science Series." (London: Cassell and Co., Ltd., 1898.)

THE lives of men to whose genius and untiring devotion to research the stately edifice of modern science owes its existence, have a fascination and an interest which appeal to a much wider circle than that of the few who are able to realise the full significance of their epoch-making scientific discoveries. Even those to whom science is little more than a name are capable of feeling a keen interest in everything that concerns the purely human element in the lives of the great leaders in science. Hence there has arisen a demand for biographical literature of this type, a demand which the "Century Science Series," to which the volume before us is the latest addition, is intended to meet.

Of all the great names in the history of science which have become household words in civilised communities, that of Michael Faraday will always stand out pre-eminently as that of one in whom genius was wedded to a childlike simplicity and transparent sincerity of character but seldom found in association with such remarkable

powers of the intellect. Faraday's career was a truly remarkable one, judged from almost every point of view. Deprived of all the advantages of a careful training in early life, and commencing the study of science at an age when the deficiencies of early education are not easily remedied, he yet, by strenuous effort and single-minded devotion to a high ideal, succeeded in working his way to the very front rank of the scientific workers of his day. Again, although in his time electrical theory was being largely developed by the great French mathematicians, and mathematical analysis was regarded as an indispensible instrument of research, Faraday, without the use of a single symbol, succeeded in discovering those great fundamental facts on which the whole structure of modern electrical engineering rests, and in determining their exact quantitative relations; he further succeeded in explaining many obscure phenomena which had eluded the grasp of the great continental mathematicians. As Clerk Maxwell discovered, he was no mathematician, yet achieved results apparently only attainable by such methods.

In the small volume before us the account of Faraday's researches is admirably rendered, and is presented in a connected manner, which enables the reader to follow the trains of thought that suggested to Faraday many of his experiments. Of peculiar interest are those negative results which must now be regarded as dim foreshadowings of later discoveries—such as the attempt to discover whether a magnetic field had any effect on the refrangibility of light when applied to its source.

But interesting as is the account of Faraday's researches to those with a moderate knowledge of physics, the general reader will probably prefer to confine his attention to the earlier and later chapters in the book, in which Faraday is presented to us from the purely human standpoint. The extracts from his letters—some of which now appear for the first time—give us interesting glimpses of his inner life. His warm human sympathies, his delight in the beauties of nature, his deep and life-long attachment to his wife, his sturdy adhesion to the religious sect in which he had grown up, his relations to illustrious contemporaries—are all topics full of interest to the general reader; and they are handled in a manner well calculated to rivet his attention and enlist his sympathy. We congratulate Prof. S. P. Thompson on having successfully brought out and emphasised the quaker-like simplicity of Faraday's character, and the remarkable freedom from complexity in which he kept his life, notwithstanding the height of his fame.

Untersuchungen über Strukturen. By O. Bütschli. Pp. viii + 411; Atlas to ditto; Plates 27. (Leipzig: W. Engelmann, 1898.)

IN this work the author sets forth in great detail the results of investigations, extending over six years, upon the minute structure of various bodies, products, for the most part, of the activity of living organisms. The object of these researches was to extend, and to put to the test, certain conclusions reached by the author in 1892, in his well-known work on the structure and physical constitution of protoplasm. In an appendix to the work in question he gave an account of some observations upon the minute structure of certain substances, such as gelatine and egg albumen, which exhibit the phenomena of swelling or of coagulation, and came to the conclusion that these substances possessed a minute structure which was finely honeycombed or alveolar ("Wabig"). In the present work these observations are renewed and greatly extended, both as regards minuteness of detail and in the variety of material. Besides researches upon gelatinous and coagulable substances such as gelatine, celloidin, albumen, and so forth, the author has studied the minute structure of various sphærocrystals, of natural and artificial cellulose structures, of starch granules, and finally of a number of natural products of animal tissues, such as chitin envelopes, spongin fibres, matrix of hyaline cartilage, and other similar structures.

To give an adequate account of these exhaustive researches, which cover more than 400 pages in the setting forth, is impossible in a short space; and it is to be regretted that the author has not anywhere given for the benefit of his readers a general summary or review of the results obtained by him. The book is, in fact, a collection of separate investigations, of which preliminary accounts have already appeared during the past seven years, bound up with an introduction and two discussions. In the introduction, the author gives an account of the order and sequence of his researches, and describes his methods of investigation, especially with regard to the technique of micro-photography. The two discussions deal with the question of the reality of the structural images obtained with the highest magnifications, and with certain phenomena of polarisation. On the other hand, the many interesting and important results obtained by the author have to be sifted out by the reader from a great mass of facts and arguments, which is no easy matter for those not specially conversant with the subject. It may be briefly stated, however, that in all the substances investigated Bütschli finds a distinct alveolar structure, which in the case of coagulable bodies is of the nature of a true foam ("Schaumig-wabig"), but which in crystallisable or sphæro-crystalline bodies is composed of an aggregation of minute globulites ("Globulitisch-wabig"). Amongst the many interesting facts which the author brings forward, attention may be specially drawn to his observations upon colloids, which when fixed in a state of tension develop appearances very similar to those seen in karyokinetic figures, suggesting the conclusion that the nuclear spindle is an expression of the effects of tension, rather than of actual differences of material between filar and interfilar substance. The author's results are supported by an atlas containing twenty-seven plates of beautifully executed micro-photographs, as well as by numerous figures in the text. All those who are interested in this very important field of investigation, to which Bütschli has devoted so many years of patient and laborious research, will welcome the appearance of this work, constituting as it does a solid contribution of facts which cannot lightly be brushed aside by those who may be opposed to his theories. E. A. M.

A Manual of Library Cataloguing. By J. Henry Quinn, Librarian Chelsea Public Libraries. Pp. 164. (London: Library Supply Company, 1899.)

THIS book is in several respects favourably distinguished from others of its class that have recently seen the light. The animosities of the library world are not imported into its pages, and in several ways the writer deprecates the subordination of practical common sense to a display of learning. He does not, for instance, condemn the unfortunate reader in search of the works of George Sand to remember that her real name was Dudevant, and to look under that heading. The book is avowedly not designed for workers in a learned institution, but is most admirably adapted for those engaged in cataloguing the contents of an ordinary library. Mr. Quinn's rules are set forth with singular clearness, and endowed with a wise elasticity. He is on the whole in favour of the "dictionary" system, wherein each book may be found, under a single alphabetical arrangement, under its title, the name of its author, and the particular portion of human knowledge with which it deals, but he also gives an adequate account of the system of "classified catalogues." An appendix gives most valuable help to the librarian in his dealings with the printer of his catalogue, and gives completeness to a most valuable little work.

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.*]

Strawberry Cure for Gout.

THE season of strawberries is at hand, but doctors are full of fads, and for the most part forbid them to the gouty. Let me put heart into those unfortunate persons to withstand a cruel medical tyranny by quoting the experience of the great Linnæus. It will be found in the biographical notes, written by himself in excellent dog-latin, and published in the Life of him by Dr. H. Stoever, translated from German into English by Joseph Trapp, 1794. Linnæus describes the goutiness of his constitution in p. 416 (*cf.* p. 415), and says that in 1750 he was attacked so severely by sciatica that he could hardly make his way home. The pain kept him awake during a whole week. He asked for opium, but a friend dissuaded it. Then his wife suggested, "Won't you eat strawberries?" It was the season for them. Linnæus, in the spirit of an experimental philosopher, replied, "*tentabo*—I will make the trial." He did so, and quickly fell into a sweet sleep that lasted two hours, and when he awoke the pain had sensibly diminished. He asked whether any strawberries were left: there were some, and he eat them all. Then he slept right away till morning. On the next day he devoured as many strawberries as he could, and on the subsequent morning the pain was wholly gone, and he was able to leave his bed. Gouty pains returned at the same date in the next year, but were again wholly driven off by the delicious fruit; similarly in the third year. Linnæus died soon after, so the experiment ceased.

What lucrative schemes are suggested by this narrative. Why should gouty persons drink nasty waters, at stuffy foreign Spas, when strawberry gardens abound in England? Let enthusiastic young doctors throw heart and soul into the new system. Let a company be run to build a Curhaus in Kent, and let them offer me board and lodging gratis in return for my valuable hints.

F. G.

Distant Sounds.

WHEN the Prince of Wales reviewed great squadrons at the Jubilee review, only one gentleman from Wimbledon, and myself, recorded hearing the salutes near London. I think it worth while, therefore, to note that what seemed to be the thumping sound of heavy guns was to be heard here to-day, from half-past five to a quarter to six p.m., Greenwich time; and even *felt* in the chest.

Some of your other correspondents may be able to tell where the guns—if guns—were fired. The importance of the subject seems to require no remark from me.

I sit in a one-storied building, as far remote from street noises, perhaps, as is possible in London, except in one or two great private gardens, or in the parks. No road is within fifty feet of me; and I know all my neighbours' noises, and have been used to the sound of old-fashioned guns up to 1894.

W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, London, S.W., June 2.

THE JUBILEE OF SIR GEORGE GABRIEL STOKES.

THE close of the present Easter term coincides with the end of the fiftieth year of the tenure by Sir George Gabriel Stokes of the Lucasian Professorship at Cambridge. Born in 1819, the same year as our Sovereign, he entered Pembroke College the year of Queen Victoria's Accession. In 1841 he took his degree as Senior Wrangler, the earliest of the wonderful group of Cambridge mathematicians—Stokes, Cayley, Adams—who occupied that position in three successive years. It has been one of the most pleasing features of the recent jubilee that Mr. H. Cadman Jones, who was second to Stokes both in the Mathematical Tripos and in the contest for the Smith's Prize, has been able to come to Cambridge to offer his congratulations to his old friend and competitor.

In the long history of the University several chairs have been held by the same professor for more than fifty years. Prof. R. Plumtre, of Queens', was Regius Professor of Physic from 1741 to 1793; Thomas Martyn, of Sidney Sussex, was Professor of Botany from 1761 to 1825; and Adam Sedgwick held the Woodwardian Chair of Geology from 1818 to 1873; but this is the first time in the history of the University that the occasion has been officially celebrated.

In the course of his long life Sir George Stokes has been first Secretary and later President of the Royal Society. He presided over the British Association in 1869. He represented the University in Parliament from 1887 to the dissolution in 1891, and was created a baronet in 1889. He has received the Rumford and the Copley medal from the Royal Society, and is a D.C.L. of Oxford, a LL.D. of Cambridge, Edinburgh and Dublin, and a ScD. of Cambridge. Amongst the numerous honours which have been showered upon him from abroad, he is a Knight of the Prussian order "Pour le Mérite," a distinction he shares with but four or five at most of his countrymen.

This is not the place to enumerate or appreciate the vast volume of published work which Prof. Stokes has produced within the last fifty years. A quarter of a century ago one of his most distinguished pupils, Prof. Tait, attempted in these pages to give some account of the magnificent series of papers we owe to Sir George. The portrait which accompanied Prof. Tait's article is still strikingly like the original; it seems strange that five-and-twenty years should have left so little trace in those finely-moulded features.

The celebration of the jubilee commenced with the delivery of the Rede Lecture by Prof. Cornu, of the École Polytechnique of Paris. The subject of the lecture was "The Wave Theory of Light, its Influence on Modern Physics." The endowment of this lecture was left to the University as long ago as 1524 by Sir Robert Rede, Lord Chief Justice in Henry VIII.'s reign, and this is the first time that it has been delivered by a foreigner. Prof. Cornu spoke in French, and both the brilliancy of his matter and the charm of his elocution made a deep impression on his audience. Prof. Cornu, in mentioning the works of Newton, Young, Clerk Maxwell, Rayleigh, Kelvin and Stokes, paid a splendid tribute to those mathematical studies which have ever been the chief glory of Cambridge.

Sir George Stokes's College, Pembroke, entertained a distinguished company at dinner on Thursday evening. The delegates from the various Universities and learned Societies were present, and many of the former members of the Society assembled to do honour to their most distinguished graduate. As it was necessary for the company to adjourn at nine o'clock to the Fitzwilliam Museum, there were no speeches, but the health of Sir George was drunk amidst a scene of rare enthusiasm.

The Fitzwilliam Museum is admirably adapted for the purposes of an evening reception. Lit up by electric light, the walls of its spacious galleries hung with pictures, and its floor covered with a crowd dressed in the robes of the various institutions that had sent delegates, it presented a most brilliant spectacle. The guests were received by the Vice-Chancellor, supported by his Esquire Bedells. During the course of the evening a bust of Sir George Stokes, executed by Mr. W. Hamo Thornycroft, was presented to Pembroke College, and a replica was at the same time given to the University. Lord Kelvin, on behalf of the subscribers, presented the busts, and in doing so he remarked that the assembly was taking part in the celebration of a great man and of natural philosophy in the University of Cambridge—natural philosophy in the broadest sense of the term, of which foundations had been laid by Sir George Stokes that would render the nineteenth century memorable in future

centuries. Sir George Stokes commenced as an undergraduate in Pembroke College: his first experimental work was made when he was a junior Fellow. He (Lord Kelvin) well remembered that in Pembroke College there were no physical laboratories, and the first physical laboratory in European Universities, he believed—certainly in these islands—was in Sir George Stokes's rooms, which he occupied as a junior Fellow about the year 1840 to 1843. If they considered the condition of natural philosophy in 1840 and in the present year, they might form some idea of how vast had been the results of his labours. Lord Kelvin pointed out that Sir George Stokes had the courage and spirit to take up subjects absolutely beyond the range of all the mathematicians of his age. Sound, light, elasticity, mathematical problems on the one hand, properties of matter on the other, were his studies, and the results had been of splendid benefit to the world of science. To him was due the credit for having published in lectures, if not in print, the grand theory of spectrum analysis. But his published papers contained but a small part of the work he had done for science. All workers in science in the University of Cambridge, all the communicators of papers to the Royal Society during the thirty years he was Secretary and the five years he was President, would agree with him in saying that Sir George Stokes had published in his own name but a very small part of the good he had done to the world. There was a debt of gratitude due to him, not only for what he had published, but for what he had done for others. He had published papers, and the discoveries contained therein had produced a monument more enduring than marble. But, still, they would like to have a marble monument, a tangible and visible sign for the men who knew him and the work he had done; and, therefore, it was a great privilege indeed to be allowed to unveil the two busts, one designed for the University of Cambridge and the other for Pembroke College.

The busts were received by the Vice-Chancellor on behalf of the University and—in the absence, through ill-health, of the Master—by the Rev. C. H. Prior, Senior Tutor of Pembroke, on behalf of the College. We are informed that Mr. Hamo Thornycroft will undertake the production of bronze copies of his bust of Sir George Stokes, about one-third of the size of the original, at a cost of seven guineas each, in case more than twenty-five are ordered. Names will be received by Sir William Crookes, 7 Kensington Park Gardens, W., and by Prof. Perry, Royal College of Science, S.W.

On Friday, June 2, the more important functions of the jubilee took place. At 11 a.m. the delegates were received by the Vice-Chancellor in the Senate House, and in the chronological order of the foundation of the institutions they represented, they tendered their addresses of congratulation to Sir George Stokes. The name of each delegate and of the institution he represented was announced by Mr. J. W. Clark, the Registrary. The delegate then advanced and presented his address to the Vice-Chancellor, who handed it to Sir George Stokes. At the close of the presentation Sir George, in a short speech, said he often thought in reviewing a long life that he might have worked harder, and he attributed his longevity to his "comparative idleness," a sentiment which found considerable favour with the undergraduates in the gallery.

The presentation commenced with the delegates from the University of Paris, and the following is a list of the institutions represented and of those chosen to represent them:—

University of France—Prof. Gaston Darboux, Doyen de la Faculté des Sciences.

University of Oxford—Sir William Reynell Anson, Bart., M.P., and Robert Edward Baynes, M.A., Lee's Reader in Physics.

University of St. Andrews—P. R. Scott Lang, M.A., Regius Professor of Mathematics.

University of Glasgow—Very Rev. Robert Herbert Story, D.D., Principal, and Lord Kelvin, M.A., Hon. LL.D., G.C.V.O.

University of Aberdeen—Sir William Duguid Geddes, LL.D., Principal.

University of Edinburgh—George Chrystal, M.A, Professor of Mathematics, and G. F. Armstrong, M.A., Professor of Engineering.

University of Dublin—George Salmon, D.D., Provost, and Benjamin Williamson, M.A., D.Sc.

Royal Society—Lord Lister, Hon. LL.D., President; Alfred Bray Kempe, M.A., Treasurer; Michael Foster, M.A., Professor of Physiology; Arthur William Rücker, M.A. (Oxon.), Professor of Physics, Royal College of Science, Secretaries.

Académie des Sciences, Paris—Prof. Becquerel.

Königliche Akademie der Wissenschaften, Berlin—Friedrich Kohlrausch, Director of the Physikalisch Technische Reichsanstalt, Charlottenburg.

Gesellschaft der Wissenschaften zu Göttingen—Edward Riecke, Professor of Physics.

New York, Columbia University—Robert S. Woodward, Ph.D., Professor of Mechanics and Mathematical Physics, Dean of the Faculty of Pure Science.

Princeton University, New Jersey—Prof. Edgar Odele Lovett.

Bataafsch Genootschap voor Physika, Rotterdam—Dr. Elie van Rijckevorsel.

Académie Royale des Sciences des Lettres et des Beaux Arts de Belgique—Prof. Alphonse Rénard, Prof. G. Van der Mensbrugghe.

Manchester Literary and Philosophical Society—Reginald Felix Gwyther, M.A., Sen. Sec.

Royal Irish Academy—Earl of Rosse, K.P., President, George F. FitzGerald, M.A., Professor of Natural and Experimental Philosophy, Trinity College, Dublin.

Royal Society of Edinburgh—Lord Kelvin, M.A., Hon. LL.D., President, and Sir John Murray, K.C.B., Hon. Sc.D.

St. Edmund's College, Ware—Right Rev. J. L. Patterson, M.A. (Oxon.), Titular Bishop of Emmaus.

École Polytechnique—Prof. Cornu and Prof. Becquerel.

École Normale Supérieure—Mons. Borel, Professor of Mechanics and Astronomy.

Royal Institution—Sir J. Crichton Browne, M.D. (Edinb.), Treasurer.

Philosophical Society of Glasgow—Lord Blythswood.

Cambridge Philosophical Society—Joseph Larmor, M.A., President.

Royal Astronomical Society—George Howard Darwin, M.A., Plumian Professor of Astronomy, President.

McGill University, Montreal—Lord Strathcona and Mount Royal, Hon. LL.D.., G.C.M.G., High Commissioner in Great Britain of the Dominion of Canada, Henry Taylor Bovey, M.A., Professor of Engineering.

University of Toronto—R. Ramsay Wright, M.A., B.Sc., Professor of Biology.

St. David's College, Lampeter—A. W. Scott, M.A., Trinity College (Dubl.), Professor of Physical Science and Mathematics.

Institution of Civil Engineers—William Henry Preece, C.B., President.

King's College, London—Archibald Robertson, D.D. (Durham), Principal.

British Association—Sir William Crookes, President.

University of Durham—Ralph Allen Sampson, M.A., Professor of Mathematics.

Cambridge Ray Club—Alfred Newton, M.A., Professor of Zoology and Comparative Anatomy.

London Chemical Society—Dr. T. E. Thorpe.

Queen's College, Belfast—Thomas Hamilton, D.D., President.

Queen's College, Galway—Alexander Anderson, MA., President.

University of Sydney—Philip Sydney Jones, M.D. (Lond.), Fellow of the Senate of the University of Sydney.

Royal College of Science, London—John Wesley Judd, C.B. LL.D., Dean; W. A. Tilden, Professor of Chemistry.

The Owens College, Manchester—Alfred Hopkinson, Q.C., M.A., Principal.

Royal Academies of Sciences of Amsterdam—J. D. van der Waals, Professor of Experimental Physics.

University of Bombay—Dr. H. M. Birdwood, M.A., C.S.I.
University of Calcutta—Hon. J. O'Kinealy, M.A., Judge of H.M.'s High Court of Bengal.
University of Madras—Hon. H. H. Shephard, M.A., Puisne Judge of the High Court of Madras.
London Mathematical Society—Lord Kelvin, M.A., Hon. LL.D., President.
University of Tokio, Keishiro Matsui, Chargé d'Affaires, Japanese Legation, London.
University of New Zealand—Edward John Routh, M.A., Sc.D.
Durham College of Science, Newcastle-on-Tyne—Henry Palin Gurney, M.A., Principal.
University of Adelaide—Horace Lamb, M.A., Professor of Mathematics in Owens College, Manchester.
University College of Wales, Aberystwyth—Robert Davies Roberts, M.A.
Yorkshire College, Leeds—Leonard J. Rogers, M.A., Professor of Mathematics.
Physical Society of London—Oliver J. Lodge, D.Sc., Professor of Physics, University College, Liverpool, President.
Mason College, Birmingham—John Henry Poynting, Sc.D., Professor of Physics.
Baltimore (Johns Hopkins)—Simon Newcomb, Hon. Sc.D., LL.D., Professor of Mathematics and Astronomy; and Professor Ames.
Firth College, Sheffield—William Mitchinson Hicks, Sc.D., Principal.
University College, Bristol—Frank R. Barrell, M.A., Professor of Mathematics.
City and Guilds of London Institute for Advancement of Technical Education—Sir Frederick Abel, Bart.
University College, Dundee—John Yule Mackay, Principal.
University College, Nottingham—John Elliotson Symes, M.A., Principal.
Victoria University—Nathan Bodington, Litt.D., Vice-Chancellor.
Royal University of Ireland—Right Rev. Monsignor Molloy, D D., D.Sc.
Royal College of Science for Ireland—Walter Noël Hartley, Professor of Chemistry.
University College, Liverpool—Richard Tetley Glazebrook, M.A., Principal.
University of the Punjab—Sir Charles Arthur Roe, M.A., late First Judge of the Chief Court, Punjab; late Vice-Chancellor of the University.
University College of South Wales, Cardiff—H. W. Lloyd Tanner, M.A. (Oxon.), Professor of Mathematics.
University College of North Wales, Bangor—Henry R. Reichel, M.A. (Oxon.), Principal.
Royal Indian Engineering College, Coopers Hill—Prof. A. Lodge, M.A. (Oxon.), Professor of Mathematics
University of Allahabad—G. Thibaut, Ph.D., Principal of the Muir Central College, Allahabad.
University of Wales—J. Viriamu Jones, M.A., Vice-Chancellor.

In addition to the delegates officially appointed, the University entertained a number of distinguished guests, amongst whom the names of the following may be mentioned:—

Captain Abney, C.B., S. Kensington; Prof. W. G. Adams, King's College, London; Prof. H. E. Armstrong, City and Guilds Institute, S. Kensington; Prof. Arrhenius, Stockholm; Prof. Ayrton, City and Guilds Institute, S. Kensington; Prof. Barker, University of Pennsylvania, Philadelphia, U.S.A.; Mr. Shelford Bidwell; Dr. Bottomley, The University, Glasgow; Mr. C. V. Boys, London; Sir Frederick Bramwell, Bart.; Dr. Haig Brown; Prof. W. Burnside, Greenwich; Prof. Clifton, Oxford; Prof. Egoroff, St. Petersburg; Prof. Esson, Oxford; Sir John Evans, K.C.B.; Prof. Carey Foster, London; Dr. F. Galton; Sir A. Geikie; Prof. Andrew Gray, Bangor; Prof. Hele-Shaw; Mr. Hubert Herkomer, R.A.; Sir J. D. Hooker, C.B., G.C.S.I.; Prof. J. Joly, Dublin; Prof. Kayser, Bonn; the Hon. Sir W. R. Kennedy; Sir J. Norman Lockyer, K.C.B.; Major P. A. MacMahon; Prof. van der Mensbrugge, Ghent; Prof. Michelson, Chicago; Prof. G. M. Minchin, Coopers Hill; Prof. G. Mittag-Leffler, Stockholm; Mr. Ludwig Mond; Mr. J. Fletcher Moulton, M.P., Q.C.; Prof. Nernst, Göttingen; Prof. Karl Pearson, University College, London; Prof. Perry, Royal College of Science; Sir John Phear; Prof. Quincke, Heidelberg; Lord Rayleigh, Lord Lieutenant of Essex; Prof. H. F. Reid, Baltimore; Prof. Osborne Reynolds, Manchester; Sir W. C. Roberts-Austen, K.C.B., Royal College of Science, London; Sir Henry E. Roscoe, Vice-Chancellor of the University of London; The Rev. Dr. Salmon, Provost of Trinity College, Dublin; Prof. Schuster, Manchester; Sir R. Strachey, G.C.S.I.; Mr. J. W. Swan; Mr. H. Thornycroft, R.A.; Prof. H. H. Turner, Oxford; Prof. Voigt, Göttingen; Rt. Rev. Lord Bishop of Wakefield; Rear-Admiral Sir William Wharton, K.C.B.; Sir W. H. White, K.C.B.

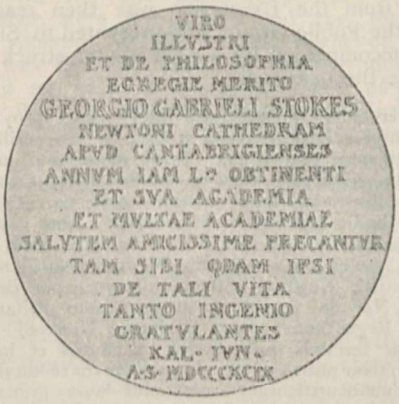
At 1.30 the Vice-Chancellor gave a lunch at Downing College to some 400 of the delegates and their hosts, and at 2.45 a congregation was held in the Senate House at which his Grace the Chancellor presided. The following address from the University was then read by Dr. Sandys, the Public Orator, and presented to Sir George Stokes, accompanied by a gold medal struck to commemorate the occasion.

Quod per annos quinquaginta inter nosmet ipsos Professoris munus tam praeclare ornavisti, et tibi, vir venerabilis, et nobis ipsis vehementer gratulamur. Iuvat vitam tam longam, tam serenam, tot studiorum fructibus maturis felicem, tot tantisque honoribus illustrem, tanta morum modestia et benignitate insignem, hodie paulisper contemplari. Anno eodem, quo Regina nostra Victoria insularum nostrarum solio et sceptro potita est, ipse eodem aetatis anno Newtoni nostri Universitatem iuvenis petisti, Newtoni cathedram postea per decem lustra ornaturus, Newtoni exemplum et in Senatu Britannico et in Societate Regia ante oculos habiturus, Newtoni vestigia in scientiarum terminis proferendeis pressurus et ingenii tanti imaginem etiam nostro in saeculo praesentem redditurus. Olim studiorum mathematicorum e certamine laurea prima reportata, postea (ne plura commemoremus) primum aquae et immotae et turbatae rationes, quae hydrostatica et hydrodynamica nominantur, subtilissime examinasti; deinde vel aquae vel aëris fluctibus corporum motus paulatim tardatos minutissime perpendisti; lucis denique leges obscuras ingenii tui lumine luculenter illustrasti. Idem etiam scientiae mathematicae in puro quodam caelo diu vixisti, atque hominum e controversiis procul remotus, sapientiae quasi in templo quodam sereno per vitam totam securus habitasti. In posterum autem famam diuturnam tibi propterea praesertim auguramur, quod, in inventis tuis pervulgandis perquam cautus et consideratus, nihil praeproperum, nihil immaturum, nihil temporis cursu postea obsolefactum, sed omnia matura et perfecta, omnia omnibus numeris absoluta, protulisti. Talia propter merita non modo in insulis nostris doctrinae sedes septem te doctorem honoris causa nominaverunt, sed etiam exterae gentes honoribus eximiis certatim cumulaverunt. Hodie eodem doctoris titulo studiorum tuorum socios nonnullos exteris e gentibus ad nos advectos, et ipsorum et tuum in honorem, velut exempli causa, libenter ornamus. In perpetuum denique observantiae nostrae et reverentiae testimonium, in honorem alumni diu a nobis dilecti et ab aliis nomismate honorifico non uno donati, ipsi nomisma novum cudendum curavimus. In honore nostro novo in te primum conferendo, inter vitae ante actae gratulationes, tibi omnia prospera etiam in posterum exoptamus.

The medal was designed by Mr. De Saulles, who designed the jubilee medals, and bears the head of the recipient in profile on the obverse, and some lines in Latin written by the Master of Trinity on the reverse. By the courtesy of the University Press, we are able to give the accompanying illustrations of the medal. The likeness is remarkably good, and the medal, replicas of which, in bronze, will be presented to the official delegates, was universally admired. We are informed that copies in bronze of the medal may be obtained from Messrs. Macmillan and Bowes. The number of medals struck is limited.

After the medal had been presented to Sir George by the Chancellor, Prof. Cornu advanced and presented on behalf of the Institute of France a copy of the Arago medal in gold. Immediately after the ceremony, honorary degrees of Doctor of Science were

conferred upon the following distinguished visitors :— Prof. M. A. Cornu, Member of the Institute of France, Professor of Experimental Physics in the École Polytechnique of Paris ; Prof. J. G. Darboux, Member of the Institute of France and Professor of Higher Geometry in the University of Paris ; Prof. A. A. Michelson, Professor of Experimental Physics in the University of Chicago ; Prof. M. G. Mittag-Leffler, Professor of Pure Mathematics at Stockholm ; Prof. G. H. Quincke, Professor of Experimental Physics in the University of Heidelberg ; and Prof. W. Voigt, Professor of Mathematical Physics in the University of Göttingen. Prof. F. W. G. Kohlrausch, Director of the Physikalisch-Technische Reichstanstalt, Charlottenburg, was unfortunately deterred by illness from attending to receive



The Stokes Jubliee Medal.

the degree which the University had been anxious to confer upon him.

The following are the speeches delivered by the Public Orator in presenting to his Grace the Chancellor the several recipients of the honorary degree.

(1) PROF. CORNU (PARIS).

Primum vobis praesento artium plurimarum Scholae Parisiensis professorem, quem in hoc ipso loco die hesterno perspicuitate solita disserentem audivistis, virum non modo solis de lumine in partes suas solvendo, sed etiam orbis terrarum de mole metienda per annos plurimos praeclare meritum. Lucis in natura explicanda, quanta cum doctrinae elegantia, quanta cum experimentorum subtilitate, quam diu versatus est. Idem quam accurate velocitatem illam est dimensus, qua per aeris intervallum immensum lucis simulacra minutissima transvolitant,

" suppeditatur enim confestim lumine lumen,
et quasi protelo stimulatur fulgere fulgur."

Lucis transmittendae in λαμπαδηφορίᾳ quam feliciter lampada a suis sibi traditam ipse etiam trans aequor Atlanticum alii tradidit.

(2) PROF. DARBOUX (PARIS).

Sequitur deinceps vir insignis Nemausi natus, Parisiensium in Universitate illustri geometriam diu professus et scientiarum facultati toti praepositus. Peritis nota sunt quattuor illa volumina, in quibus superficierum rationem universam inclusit ; etiam pluribus notum est, quantum patriae legatus deliberationibus illis profuerit, quae a Societate nostra Regia primum institutae, id potissimum spectant, ut omnibus e gentibus quicquid a scientiarum cultoribus conquiritur, indicis unius in thesaurum, gentium omnium ad fructum, in posterum conferatur. Incepto tanto talium virorum auxilio ad exitum perducto, inter omnes gentes ei qui rerum naturae praesertim scientiam excolunt, sine dubio vinculis artioribus inter sese coniungentur.

(3) PROF. MICHELSON (CHICAGO).

Trans aequor Atlanticum ad nos advectus est vir insignis, qui ea quae professor noster Lucasianus de aetheris immensi regione, in qua lux propagatur, orbis terrarum motu perturbata, olim praesagiebat, ipse experimentis exquisitis adhibitis penitus exploravit. Lucis explorandae in provincia is certe scientiarum inter lumina numeratur, qui olim fratrum nostrorum transmarinorum in classe non ignotus, lampade trans oceanum e Gallia sibi tradita feliciter accepta, etiam exteris gentibus subito affulsit, velocitatem immensam eleganter dimensus, qua lucis fluctus videntur (ut Lucretii verbis utar)

" per totum caeli spatium diffundere sese,
perque volare mare ac terras, caelumque rigare."

(4) PROF. MITTAG-LEFFLER (STOCKHOLM).

Scandinavia ad nos misit scientiae mathematicae professorem illustrem, qui studiorum suorum velut e campo puro laudem plurimam victor reportavit. Idem Regis sui auspiciis, qui praemiis propositis magnum huic scientiae attulit adiumentum, etiam exterarum gentium ad communem fructum prope viginti per annos Acta illa Mathematica edidit, quae in his studiis quasi gentium omnium internuntium esse dixerim. Ipse Homerus (ut Pindari versus verbo uno tantum mutato proferam) ἄγγελον ἐσλὸν ἔφα τιμὰν μεγίσταν πράγματι παντὶ φέρειν· αὔξεται καὶ Μάθησις δι' ἀγγελίας ὀρθᾶς.

(5) PROF. QUINCKE (HEIDELBERG).

Universitatem Heidelbergensem abhinc annos quadraginta professorum par nobile spectroscopo invento in perpetuum illustravit. Adest inde discipulorum plurimorum in scientia physica praeceptor, qui et in instrumentis novis inveniendis sollertiam singularem et in eisdem adhibendis industriam indefessam praestitit. Ei qui in scientiae physicae ratione universa versati, viri huiusce inventis utuntur, etiam de sua scientia verum esse confitebuntur, quod de arte oratoria praesertim dixit Quintilianus :—" in omnibus fere minus valent praecepta quam experimenta."

(6) PROF. VOIGT (GÖTTINGEN).

Universitatem Goettingensem, a Rege nostro Hanoveriensi Georgio secundo conditam, vinculo non uno cum Universitate nostra coniunctam esse constat. Constat eandem etiam per annos prope quinquaginta Caroli Frederici Gaussii, scientiae mathematicae et physicae professoris celeberrimi, gloria esse illustratam, qui cum ingenio fecundissimo disserendi genus consummatum coniunxit. Iuvat inde professorem ad nos advectum excipere, qui scientiae eiusdem pulcherrimam nactus provinciam, etiam lucem ipsam et crystalla ingenii sui lumine illustravit.

After the congregation, a garden party was held in the beautiful old gardens of Pembroke College, where a numerous and brilliant company assembled and listened to the music of the Royal Artillery Band.

In the evening, a dinner, at which were present some 220 of the guests of the University and their hosts, took place in Trinity College Hall. His Grace the Duke of Devonshire presided, and after the health of the Queen had been drunk he proposed, in a felicitous speech, the health of the hero of the day. The toast was drunk with the greatest enthusiasm. The only other toasts were "The Guests," proposed by Prof. George Darwin, and responded to by Lord Lister ; and "The Chancellor," proposed by the Vice-Chancellor. In responding, the Chancellor thanked the Master and Fellows and Trinity

for their hospitality in granting the use of the Hall, and Dr. Butler replied on behalf of the College.

In addition to the guests who were more directly associated with the celebration of the jubilee, the following were present at the banquet :—Mr. Justice Mathew, the High Sheriff of Cambridgeshire, the Lord Lieutenant of Cambridgeshire, the Bishop of Ely, the Right Hon. A. J. Balfour, and many other distinguished guests.

This dinner brought the official proceedings to an end, but on Monday a meeting of the Philosophical Society was held for the presentation of papers to be published in a special volume of the Society's *Transactions* commemorative of the long connection of Sir G. G. Stokes with the Society. The following are amongst those who formally communicated papers :—

I. By Prof. M. G. Mittag-Leffler : On the analytical representation of a uniform branch of a monogenic function.
II. By Prof. H. Poincaré : The theory of groups.
III. By Dr. L. Boltzmann :
IV. By Prof. A. Righi :
V. By Prof. A. A. Michelson : On the echelon spectroscope.
VI. By Major P. A. Macmahon, R.A. : Application of the partition analysis to the study of the properties of any system of consecutive integers.
VII. By Lord Kelvin : On diffraction of solitary waves.
VIII. By Prof. A. Schuster : On the periodogram of magnetic declination derived from twenty-five years' observations at the Greenwich Observatory.
IX. By Prof. W. D. Niven : A general method of determining free electric distributions by successive approximations.
X. By Prof. G. D. Liveing : The influence of temperature on the absorption spectra of salts.
XI. By Prof. A. R. Forsyth : On the integrals of systems of differential equations.
XII. By Mr. J. Larmor : On the general theory of the optical relations of magnetism.

Together with papers by Prof. J. J. Thomson, Dr. E. W. Hobson, Mr. E. H. Griffiths, Mr. W. N. Shaw, Mr. E. W. Brown, and Mr. H. M. Macdonald.

In conclusion, it may be stated that from beginning to end the celebration was a complete success. The weather played an important part in securing this success, but the thanks of all who assisted at the jubilee must also be tendered to those at Cambridge who took such careful forethought for their convenience and comfort.

The Cambridge Review for June 1 publishes several contributions referring to the jubilee, and issues as a special supplement an excellent portrait of Sir George Stokes. Prof. J. J. Thomson gives an appreciative account of the scientific career and work of the esteemed Lucasian Professor. In concluding the article, he remarks :—

"By his researches on hydrodynamics he has founded a new branch of the science ; in optics he has, to use the words of Lord Kelvin, been the teacher and guide of his contemporaries ; he was the first to enunciate in his lectures the principles on which spectrum analysis is founded ; he unravelled the laws of fluorescence ; he investigated the variation of gravity over the surface of the earth ; he has solved problems of the greatest difficulty in pure mathematics ; while the latest of his long series of researches is his remarkable paper on the nature of the Röntgen rays. His papers are the classics of science ; they are remarkable, not only for the results obtained, but also for their perfect clearness of expression and thought, for the elegance of the mathematical methods, for their maturity of judgment and for that care and finish on which so much of the impressiveness of a paper depends.

The little more and how much it is,
The little less and what worlds away.

These researches show the combination of supreme mathematical and experimental power ; with simple apparatus and without the appliances which are now at the command of physicists, he has made experiments which have settled some of the most crucial points in optics, and which will be quoted as long as science exists. The rooms in Pembroke, where he made many of his experiments, will in the history of science and of the University be associated with those in the Old Court of Trinity, where Newton made the prism reveal the nature of white light. And, indeed, there are many points of resemblance between the careers of Newton and of Stokes : both held the Lucasian Professorship, both were Presidents of the Royal Society, both represented the University in Parliament ; and the resemblance is not confined to the offices they held, it extends to their type of mind. Often, in reading Stokes's papers, we feel this is just how Newton would have treated this point, these are the deductions which Newton would have drawn."

Prof. Jebb contributes the following ode to the *Cambridge Review*.

TO SIR GEORGE GABRIEL STOKES.

JUNE 1, 1899.

Clear mind, strong heart, true servant of the light,
True to that light within the soul, whose ray,
Pure and serene, hath brightened on thy way,
Honour and praise now crown thee on the height
Of tranquil years. Forgetfulness and night
Shall spare thy fame, when, in some larger day
Of knowledge yet undream'd, time makes a prey
Of many a deed and name that once were bright.

Thou, without haste or pause, from youth to age,
Hast moved with sure steps to thy goal. And thine
That sure renown which sage confirms to sage,
Borne from afar. Yet wisdom shows a sign
Greater, through all thy life, than glory's wage ;
Thy strength has rested on the Love Divine.

CENTENARY OF THE ROYAL INSTITUTION.

THE celebration of the centenary of the foundation of the Royal Institution was commenced on Monday by a banquet given by the managers of the Institution in the Hall of the Merchant Taylors' Company. The Duke of Northumberland, president of the Institution, occupied the chair. The Prince of Wales was present, and a number of distinguished men of science were among the guests. Reference to a few points connected with the history and work of the Institution were made in the course of the evening. In acknowledging the toast of his health, the Prince of Wales said :

I consider it a great privilege and honour to take part, as vice-patron of this Institution, in the celebration of its 100th anniversary. I had an early acquaintance with the Royal Institution. Although it is nearly half a century ago, I have not forgotten that just after Christmas my brother, the Duke of Coburg, and myself were sent to attend the lectures given by the great Prof. Michael Faraday. I have not forgotten the clear way in which Prof. Faraday explained difficult scientific problems, and showed the chemical experiments which were then the order of the day. Among the most remarkable discoveries with which the Institution is associated is that of Davy, which has saved thousands of lives. It is needless to speak of the researches of Faraday, whom I knew ; and in our own time of the remarkable achievements in several branches of science of Lord Rayleigh. I thank you once more most cordially, and express my high appreciation of this great and important centenary event. I am glad also to see so many distinguished foreigners who have come over to take part in this interesting gathering.

The Duke of Cambridge proposed "The Royal Institution of Great Britain," and in doing so remarked that the declared object of the Institution was the diffusion of knowledge and the

introduction of useful mechanical inventions, and the means were to be courses of philosophical lectures and experiments illustrating the applications of science to daily life.

The Chairman, in acknowledgment of the toast, said that it was a great honour that so many eminent representatives of foreign science had honoured with their presence the centenary of the Institution. It was just 100 years ago when the Institution entered upon its present premises. A long roll of names had lent lustre to their labours. Davy, Faraday, Young, Tyndall—above all, they should remember their founder, Benjamin Thomson, Count Rumford, whom it was easy to criticise, but whose virtues had been productive of great results. The work of the Institution had been in large measure the carrying out of Count Rumford's ideas. It was said that he intended an institution of a more practical or industrial character than the Institution now was. But changes had taken place. Facilities for communicating new discoveries were 100 years ago few; competition was less keen; there was then much dislike of innovation, and there was extreme jealousy with the working classes of any reduction of manual labour. It was thus necessary to popularise discoveries; and that was the aim of their founder. But now every such discovery was soon heralded to the public. Popular magazines had now articles on the manufacture of liquid air and other subjects of an abstruse character. Towards this wide diffusion of science the Royal Institution had largely contributed. Their principal objects were research, for which their laboratories gave ample means, and in respect of which special gratitude was due to Dr. Mond for his noble gift, and to Mr. Spottiswoode for his collection. The second object was to bring the results of research to the knowledge of those who could appreciate them, and these results were expounded in the evening lectures of the Institution. Thirdly, this knowledge was popularised by the afternoon lectures; and, finally, the rising generation were stimulated by the juvenile lectures to those who, it was hoped, were destined to take their part in future scientific investigation.

On Tuesday afternoon a commemoration lecture was delivered at the Institution by Lord Rayleigh, the Prince of Wales being present.

In the course of his remarks, Lord Rayleigh is reported by the *Times* to have said that though his was intended to be a commemorative lecture, the idea of commemorating all the work that had been done at the Royal Institution was hopeless. Remembering that on other occasions he had spoken of the achievements of Faraday and Tyndall, he thought on this occasion he would do well to go still further back in the century and speak of Dr. Thomas Young, one of the earliest professors of the Institution. Young occupied a very high place in the estimation of men of science—higher, indeed, now than at the time when he did his work. His "Lectures on Natural Philosophy," containing the substance of courses delivered in the Institution, was a very remarkable book, which was not known as widely as it ought to be. Its expositions in some branches were unexcelled even now, and it contained some things which, so far as he knew, were not to be found elsewhere. The earlier lectures dealt with mechanics, and the reader would find as sound an exposition of that science as could be imagined. Elastic resilience, or what we should now call potential energy, was better dealt with there than in any other treatise he knew, for Young discussed the subject with remarkable ingenuity, showing that the phenomena exhibited by two bodies coming into collision were comprehended under two cases. In the province of sound, Young was the originator of many of the most important principles on which the doctrine was now expounded, but it was with optics that his name was most closely associated, for Fresnel and he were the builders of the great structure of the undulatory theory. Lord Rayleigh then mentioned some of the points in which Young's good work had been overlooked. In Young's time one question of discussion was the change of the focus of the eye for varying distances. One suggested explanation, that accommodation was affected by an alteration in the external convexity of the eye, Young proved to be wrong by drowning his eye in water. This virtually altered the convexity, yet the power of accommodation remained, and he therefore concluded it was due to a muscular alteration in the internal lens of the eye. Young was singularly successful in the theory of cohesion and capillarity, in which some of his earliest work was done, and he was the first to deduce an estimate of molecular dimensions from data afforded by that theory. The size of the molecule, according to his calculations, was not very different from that admitted at the present day. In the theory of the tides he made great advances, while his views on heat were very interesting, since he had the utmost contempt for the idea prevalent in his time that it was a separate entity, and expressed the hope that in time philosophers might arrive at a true conception of its nature as motion. Speaking of work which had been done at the Institution by men who held no regular appointment in it, the lecturer noted that Wedgwood, in conjunction with Davy, was the first to produce anything that could be called a photograph, while instantaneous photography, such as was required for rapidly moving objects, was carried out for the first time by Fox Talbot in the laboratory of the Institution.

Another commemoration lecture is to be delivered as we go to press. Upon the invitation of the teachers of natural science in Oxford University, honorary members of the Institution will visit the University to-day.

The principal historical apparatus in the Institution has been on view during the centenary celebration. An interesting souvenir of the centenary is an illustrated brochure referring to William Spottiswoode, and to his collection of physical apparatus just presented to the Institution by his son, Mr. W. H. Spottiswoode. The souvenir includes a memoir of Spottiswoode, reprinted from NATURE of April 26, 1883; a list of lectures delivered by him at the Royal Institution, notes on some of the more important objects in the collection of apparatus, a reprint of a paper by Spottiswoode on the laboratories of the Institution, and a chronological list of original work developed at the Institution. A photogravure of Spottiswoode, and a number of brilliant half-tone pictures of sets of objects in the collection of apparatus, form part of Mr. Spottiswoode's interesting pamphlet.

THE HEIGHT OF THE AURORA.[1]

A GOOD story used to be told some years ago of a candidate, who, when undergoing the torture of a *vivâ voce* examination, was unable to reply satisfactorily to any of the questions asked. "Come, sir," said the examiner, with the air of a man asking the simplest question, "explain to me the cause of the aurora borealis." "Sir," said the unhappy aspirant for physical honours, "I could have explained it perfectly yesterday, but nervousness has, I think, made me lose my memory." "This is very unfortunate," said the examiner, "you are the only man who could have explained this mystery, and you have forgotten it." One is not prepared to say that exact and complete knowledge of the cause of this curious phenomenon has greatly advanced since the time when the examiner made this crushing rejoinder, and it is therefore fortunate to have to treat of only one of the difficulties with which the whole problem is beset—the height at which the light manifests itself, or the limits of altitude above the earth's surface at which it may be seen. But a preliminary difficulty arises in connection with even this bare statement. Is the aurora borealis a localised phenomenon? Has it a habitation as well as a name? Or is it, like the rainbow, an optical exhibition resulting from the operation of certain physical causes. In the case of the rainbow, the causes admit of a tolerably simple explanation, and little is to be learnt from the study of its general features as seen in the sky; certainly we should not think it betokened any great show of wisdom to attempt to determine its height by any method of measurement or triangulation. The angular altitude is settled for us in a quite different manner, and it may

1 "The Altitude of the Aurora above the Earth's Surface." By Prof. Cleveland Abbe. ("Terrestrial Magnetism," vol. iii., 1898.

be that we are displaying a crass ignorance in endeavouring to apply to auroræ methods of measurement which depend for their success upon an apparent displacement, due to a real change in the position of the observer. Students of trigonometry are taught at a very early stage the method of determining the distance of an inaccessible object, visible from two positions, and the elementary process employed, depending on the solution of a triangle, remains the favourite method of determining the height of the aurora. But just as our student knows that a successful solution of the problem demands that the angles must refer to a concrete object, so the observer of an aurora asks that this fitful light should have a definite "locus," that can be simultaneously seen and identified by two or more observers. Practically, this fundamental condition is not always easily satisfied, and other methods have in consequence been suggested which are founded on a supposed knowledge of the origin and behaviour of the auroral light. We may say at once that these methods, often ingenious in themselves, are so unsatisfactory in application that they can be passed over with a very brief mention.

There is no doubt but that the light out of which the auroral phenomena are formed emanates from a certain circumscribed region, but the real question is whether the arches and beams, the streamers and waves, the curtains and folds, with all the varied nomenclature that has been used to describe special features, are definite concrete objects. The fact that the aurora is accompanied with a special and presumably constant spectrum, possessing easily recognisable characteristics, does not help us at all to settle the question. That we have a source of light is admitted. The point at issue is, to what extent is it a subjective phenomenon, and how far does each observer see his own aurora as an optical illusion. Manifestly, those who accept the subjective theory have to encounter many objections. No one likes to admit that he is deceived in the character of a phenomenon so apparently real as that presented by a fine auroral display, though he will readily acknowledge that perspective must introduce some misleading features. Prof. Cleveland Abbe has, however, summed up the evidence with great care and completeness, and come to the conclusion that the idea of an individual existence must be definitely relinquished. He has been led to this conclusion from an examination of the various attempts that have been made to determine the height of the aurora; and whether we accept this decision or not, we shall at least be prepared to follow him in the assertion that the determination of the altitude of the aurora is a much more delicate problem, and perhaps also a more indefinite problem, than we have hitherto believed.

The evidence tending to this latter conclusion can be divided under many heads. We shall content ourselves with exhibiting two—one depending upon actual observation and measurement, the other resting upon theory and suggestion. The observers who have made the height of the aurora a special study can be grouped into two families—one represented by Richardson, Franklin, Hooker, and Silberman, who have actually seen the aurora below the clouds, or between themselves and neighbouring objects; and others like Loomis, Boscovich, and Twining, who place the height anywhere between 400 and 1000 miles. Between these advocates for a "ground" theory, and those who perceive a high aerial origin, we have a whole host of observers who are mainly led to their results by the selection and rejection of certain of their observations, if they are numerous, or have drawn their conclusions from single and accidental results. For the statement of claim of those who argue that the aurora is entirely confined to the lowest stratum of the earth's atmosphere, we must trust entirely to description. Measurement can evidently play no part, any more than it can on a bank of fog or a shower of hail. An admirable description, and one that would carry conviction to every impartial reader, if we could give it fully, has been written by Prof. J. P. Lesley, the distinguished geologist, of what he saw at Little Glace Bay, about seventeen miles from Sydney, Cape Breton: "It was my good fortune to observe an aurora, which to my eyes was embodied in and swept the earth with successive banks of Cape Breton fog. . . . In this fog bank hung, as it were, a brilliant curtain of light, with a wide fringe or flounce of maximum brilliancy, along the bottom edge, the light fading upwards along the curtain, but traceable to the very zenith, and the curtain stretching from the eastern horizon out at sea to the western horizon on the low hill-tops. The perspective was perfect. The curtain was evidently vertical, thin, straight, long enough to reach from one limit of the vision to the other, and floating broadside before the south wind towards the north. No reasoning could convince us (he had a companion) that these were not elements of the phenomenon, and, moreover, that the lower edge of the bright fringe was more than one or two hundred yards away at its nearest point when we first saw it. Its rate of departure from us was evidently that of the fog bank, or that of the gentle south wind then blowing. The perspective of the whole curtain changed in conformity with that supposition. We had both spent our lives in topographical work, and no record of triangulation made upon this aurora would alter my conviction of the posture and movements of the beautiful object, derived from the natural triangulations of the unassisted eye." Prof. Lesley further relates that he witnessed successive repetitions of the same beautiful appearance, but feebler in intensity, as though produced by the same causes gradually growing less and less active, from a process of exhaustion. Of the accuracy of his testimony he can entertain no doubt, and urges that it is unreasonable that the positive observations of those who have witnessed these displays should be despotically overriden by the trigonometrical calculations of other students. We are inclined to agree with him. It might, of course, be urged by those who consider that the upper and attenuated regions of the atmosphere are necessary for the production of auroral light, that such an exhibition was not a true aurora, and that if examined spectroscopically the light would not show the characteristic lines, nor would the magnetic instruments in the neighbourhood be agitated in the manner with which we have been made familiar when auroræ are present. On these points there seems to be no evidence, nor, so far as is known, have other physicists, who, like General Sabine, have "walked through an aurora as one would pass through a mist," verified their convictions.

But if the deductions of those who trust to the evidence of their senses can be set aside as affected by self-deception, others who rely on elaborate measurements are hardly in better case. With more pretentious methods, more rigorous criticism can be applied. Into the details of this criticism it is not convenient to enter here, involving as it does that much-debated quantity the "probable error," and still more recondite criteria for the rejection of discordant observations. But we have a right to expect an intelligible result, and this is not in every case forthcoming. If a man carefully surveyed a field with the view of determining its superficial area, brought out as his result a minus quantity, we should necessarily have a difficulty in explaining his deductions. And, without any exaggeration, it is precisely results of this character which are too frequently obtained from attempted measurements of auroræ. Of course, in the case of an object so ill-defined as an auroral arch, one expects to find large observational errors. But these

errors should have less effect in proportion as the conditions for securing accuracy in the solution of the problem increase. For instance, if we are going to measure a distance of two, four, or six hundred miles, a base of a mile or less in length will give us a very ill-conditioned triangle; but as we increase the length of the base, we should expect greater consistency in the results. Unfortunately this expectation is not realised. As an illustration, we select, out of the mass of measures that Prof. Cleveland Abbe has collected, three series of observations. The earliest of these sets was made in 1839, by MM. Bravais and Lottin in Norway, in latitude about +70°. The stations selected provided a base line about ten miles in length. Even at this moderate distance, the two expert observers could not recognise the same features in the auroral arch, or be certain that the angles measured with their theodolites referred to the same point. But Bravais, greatly daring, boldly applied trigonometrical methods, and deduced a parallax with mathematical rigour. Out of seven measures, as shown below, three parallaxes are negative and four positive, the total range being more than eleven degrees.

	Parallax		Parallax
	h. m. ° ′		h. m. ° ′
1839 January 12,	5 37 −3 42	1839 January 21,	6 2 −1 34
,, ,, 12,	6 2 +2 13	,, ,, 21,	7 3 +1 4
,, ,, 12,	9 30 +9 52	,, ,, 21,	7 33 +0 45
,, ,, 12,	10 36 −0 8		

Bravais concluded from all his observations that the mean altitude of the auroral arch is between 100 and 150 kilometres, but suggested that in order to determine "the parallax of the aurora more precisely than we have been able to do, it would be necessary to employ a longer base than ours, say about 100 kilometres in length, and directed as nearly as possible parallel to the vertical plane through the culmination of the arch." Fifty years later, Bravais' suggestion was carried out. Tromholt of Rostock, in Norway, occupied one of the stations near the scene of Bravais' earlier investigations, but extended the base line to a length of 66 miles. From one end of this base line, Tromholt made no less than 634 measurements, while 367 were made from the companion site. On comparing the results, however, only sixty corresponded as to time and referred, or were supposed to refer, to identical objects. These sixty were again reduced to forty-two, for reasons which do not appear; but it would be scarcely uncharitable to suggest that the remainder gave negative or impossible parallaxes. This modest remainder reminds one of Falstaff's "half-penny-worth of bread to his intolerable deal of sack." The final result, however, taken for what it is worth, assigns altitudes to the auroræ varying from 19 to 217 kilometres. Variations so great in amount cannot inspire confidence.

It might, however, be objected that in the Tromholt series, since the observers were separated some 100 km., that only the upper features of the aurora could be visible simultaneously from both stations, and that if the true or localised aurora was confined to the lower strata of the atmosphere, more or less illusory results might be expected. But we have a third series, made in about the same latitude, in which the observers were stationed only about a third of a mile apart, where they were in constant telephonic communication with each other, and where, therefore, the conditions were favourable to the removal of some of the difficulties that beset the parallactic method. Without quoting in detail the results obtained, it will be sufficient to say that, on discussion, the number of positive and negative parallaxes, even after judicious rejections, was found to be seventeen and twenty-three respectively, and that consequently no trustworthy value of the height could be deduced. Prof. Cleveland Abbe shows in this particular case how the calculus of probabilities has been forced in order to derive a plausible altitude from these observations. There is, however, no necessity to labour the point. We are simply concerned to show that the method tried under various conditions fails to give consistent results. Those who believe that the aurora is confined to the upper regions of the atmosphere reject the largest parallaxes, while those who are fighting for a low aurora will only accept the large values. The one fact which seems to stand out clearly after much patient examination is that the parallax does not increase with the increase of the length of the base line, or, in other words, it cannot be a true parallax. There is no dearth of reasons to explain these discrepant results. The inevitable error of observation arising from the feebleness of the light, the want of clear definition at the boundary of the arch, the possible movement of the object itself, and the want of absolute synchronism in the measurements at the stations, would be more than sufficient to make the method untrustworthy.

In presence of these difficulties, other methods depending on quite different principles have, as before intimated, been suggested and applied. The general principle involved is to derive the height from observations made at a single station, thus eliminating the second observer and the errors he introduces, putting in his place some more or less plausible suggestion as to the origin of the aurora itself. Galle, for instance, assumed that an auroral streamer is parallel to a free magnetical needle on the earth's surface, vertically below the beam. By observing the zenith distance of the auroral corona in his magnetic meridian, he obtained the angle made by his vertical with the parallel lines of light that compose the aurora, or the dip of the needle suspended in the region whence the light emanates. The magnetic charts show at what point on the earth's surface the needle would have the same dip. This gives a right-angled triangle whose base is known, and whose vertical side is the desired height. The weak point in the method is the assumption that the dip of the needle in the place where the corona is presumed to be coincides with that at the earth's surface immediately beneath it. Another method that has been applied is due to Bravais. It assumes that the auroral arch throughout its whole extent exists at a uniform distance above the earth's surface. If this assumption were justified, the determination of the azimuth and altitude of the two ends, and of the summit of the arch, would lead to a knowledge of its height. The method has been repeatedly tried with some modifications concerning the curvature of the arch, and of the position of the centre of the circle; but the very number of the variations that have been made condemns the accuracy and the applicability of the method. The observed apparent velocity of the motion of the arch, as seen from two stations in a magnetic meridian, has also been tried; and indeed, without further enumeration of the plans that have been suggested, one may say that the ingenuity and industry brought to bear upon this problem have been such, that if the definite beams and arches possessed a real existence and a definite locus, its solution would have been assured. That the parallax has remained so long indeterminate is probably due to the fact that the question has not been broached along appropriate lines. In his careful review, Prof. Cleveland Abbe makes some practical suggestions which, if applied, would go a great way to show how far optical illusion and perspective displacement affect this luminous phenomenon, which for so long has supplied poets with a simile for instability, and which under scientific examination gives additional point to the well-known lines of Burns:—

"Like the Borealis race
That flit ere you can point the place."

THE TOTAL ECLIPSE OF THE SUN, MAY 1900.

WE have received the following circular from the U.S. Naval Observatory, Georgetown Heights, Washington, D.C., dated May 17.

In anticipation of the total eclipse of the sun May 28, 1900, the United States Navy Department has arranged with the Secretary of the Treasury to have admitted free of duty the instruments of foreign astronomers who may come to this country to observe the eclipse.

To this end astronomers abroad who contemplate an expedition to the United States are invited to notify the Superintendent of the Naval Observatory of the probable date of their arrival, with the name of the port at which they propose to disembark. The Navy Department will forward to the consuls of the different countries to which these observers belong, stationed at the ports in the United States at which the gentlemen shall arrive, a letter stating their purpose in travelling, which letter will be countersigned by the consul and presented to the collector at the port as a proof of their identity. Upon this the collector will extend all proper facilities for the speedy delivery of the instruments in question, free of duty and charges.

The Superintendent of the Observatory will be glad to hear from each of the proposed expeditions, in order that he may render such assistance as lies in his power. The path of totality extends through a thickly settled portion of the country, including some principal cities. Facilities for transportation are excellent, but it is recommended that instruments be securely packed and marked "delicate instruments—handle with care." The climate at that season is warm. The chances for clear weather are good.

Full information regarding routes of travel to proposed points, and other particulars, can best be obtained through consuls. Through the regular diplomatic channels notice should be conveyed to the local authorities of the city or town selected as a post of observation.

This Observatory will issue a pamphlet of instructions, containing large scale maps showing path of totality.

C. H. DAVIS,
Captain, U.S.N., Superintendent.

NOTES.

THREE Fellows of the Royal Society have had honours conferred upon them on the occasion of her Majesty's eightieth birthday. Prof. J. S. Burdon Sanderson, Regius professor of medicine in the University of Oxford, has had the dignity of a baronetcy conferred upon him; and physiology is also honoured in the person of Prof. Michael Foster, joint-secretary of the Royal Society, and president-elect of the British Association, who has been appointed to be K.C.B. The promotions from C.B. to K.C.B. include Mr. W. H. Preece, who recently retired from his position as engineer-in-chief of the General Post Office.

AT the annual meeting of the Royal Society for the election of Fellows, the fifteen candidates nominated by the Council were elected into the Society. The names and qualifications of these candidates were given in NATURE of May 11 (p. 31).

THE five vacancies in the list of Foreign Members of the Royal Society have been filled by the election of the following: Prof. Ludwig Boltzmann, of the University of Vienna; Prof. Anton Dohrn, late Director of the Zoological Station, Naples; Prof. Emil Fischer, of the University of Berlin; Dr. Neumayer, of Hamburg; and Dr. Treub, Director of the Botanical Gardens, Buitenzorg.

THE Académie Royale des sciences de Turin announces that the Vallauri prize of 30,000 lire (£1200) will be awarded for the most important and celebrated work in the realm of physical science—using this term in a wide sense—published between January 1 of this year and December 31, 1902. The prize will be awarded without consideration of nationality, and no members of the Academy can participate in the competition. No account will be taken of works in manuscript. The president of the Academy is Prof. Guiseppe Carle, the secretary of the section of physical sciences is Prof. A. Naccari.

THE anniversary meeting of the Royal Geographical Society was held on Monday, and the medals awarded by the Council of the Society, as announced in our issue of May 11, were presented. The meeting was also made the occasion for the American Ambassador to present Sir John Murray with the gold medal awarded to him by the Geographical Society of New York. The medal contains the following inscription:—"Cullum Geographical Medal. Awarded to Sir John Murray, K.C.B., naturalist, deep sea explorer, oceanographer, editor of *Challenger* Reports, 1899."

IT is reported that the *Bakan* transport has left the Neva on her voyage to Spitsbergen. She has a crew of ninety men and eight officers, including Captain Ergomysheff, who is in command.

EFFORTS are being made in New York to form an American Physical Society similar to the Physical Society of London and the Deutsche physikalische Gesellschaft.

IT is announced in *Science* that Prof. F. L. O. Wadsworth has been appointed by the managers of the Western Pennsylvania University to succeed Prof. J. E. Keeler as director of the Allegheny Observatory. Dr. J. L. Wortman, of the American Museum of Natural History, has resigned his position in the museum in order to take charge of the new collections of vertebrate fossils in the Carnegie Museum at Pittsburg.

THE Rome correspondent of the *British Medical Journal* states that since the beginning of May, Prof. Koch and his assistants have installed themselves at the Municipal Hospital of Grosseto, where they are continuing their researches on malaria. Grosseto is a town situated in the line between Genoa and Rome, and is surrounded by an extensive plain, which in olden times was the Lacus Prelius of Cicero. This lake gradually became a morass and caused malaria. By skilful drainage and other means, the Italian Government has converted nearly the whole of this morass into valuable pasturage, and has thus lessened greatly the malaria. It is said that Prof. Koch intends to go to South Africa to continue his studies there when he leaves Grosseto.

A REUTER telegram from Stockholm, dated June 6, says that the Anthropological and Geographical Society in Stockholm has received the following telegram from Herr Vathne, a shipowner at Mandal:—"Captain Hueland, of the steamship *Vaagen*, who arrived there on Monday morning, reports tha when off Kola Fjord, Iceland, in 65° 34′ north lat., 21° 28′ west long., on May 14 he found a drifting buoy marked 'No. 7.' Inside the buoy was a capsule, marked 'Andrée's Polar Expedition,' containing a slip of paper, on which was written the following:—'Drifting buoy, No. 7. This buoy was thrown out from Andrée's balloon on July 11, 1897 10.55 p.m., Greenwich mean time, 82° north lat., 25° east long. We are at an altitude of 600 metres; all well. Andrée, Strindberg, Fraenckel.'" Herr Andrée made his ascent from Danes Island on July 11, 1897, at 3 o'clock in the afternoon, so that when the buoy was thrown out the explorer had only travelled seven hours and fifty-five minutes.

A CONFERENCE of representatives of Sea Fishery Boards with officials of the Board of Trade took place at Westminster on Tuesday, under the presidency of Mr. Ritchie. In his remarks

upon opening the proceedings, Mr. Ritchie referred to the forthcoming fishery conference at Stockholm, and said that whilst the Government were anxious to have the purely scientific branch of the subject dealt with, they had also instructed their delegates to see whether some agreement could not be come to whereby there should be an increase of the productiveness of the fisheries, and thus secure a permanent increase of fish in the markets adjoining the North Sea. Sir John Murray, Mr. Arter, and Prof. D'Arcy Thompson will represent the Government at the conference.

THE following State legislation in 1898, mentioned in the *American Naturalist*, is of interest to naturalists. New Jersey has provided for a State entomologist; Louisiana has passed a Bill providing for the establishment of a biological station in the Gulf of Mexico, to co-operate with the United States Fish Commission for the investigation of problems affecting the fisheries of the State; New York has forbidden the killing at any time of wild moose, elk, caribou, and antelope; Ohio has repealed the law relative to the trapping or killing of musk-rats, mink, and otter.

SIR CHARLES TODD has communicated some interesting notes to the Adelaide *Advertiser* of April 18, relating to the meteorology of South Australia during the past summer (November to March). November was one of the coolest on record, being 2°·8 below the average; this was followed by a hot December, with a mean temperature of 76°·4, which has only once been exceeded. January was the coldest during the forty-two years' records at Adelaide, and was followed by a hot February. The highest temperature during the month was 113°·6, which was the hottest day since January 1880. During the summer the thermometer read over 90° on forty-two days, of which about half were over 100°. The mean temperature for the five months, 71°·6, is just above the average.

AN apparatus, by means of which a record is automatically taken of the extent to which the steering wheel of a ship is moved and the helm put over, has been devised by Mr. J. E. Liardet. The apparatus consists principally of a couple of drums on which a "tape" or long strip of paper is wound. The movement of the wheel actuates these drums, unwinding the tape from one and winding it on the other, the motions being obtained by suitable toothed gearing. In the same way, a pencil fixed to a holder is caused to move to one side of the central line of the paper if the helm is put to port, and the other side when the helm is starboarded, the amplitude of the movement of the pencil being proportionate to the angle of helm. In this way, an accurate record may be kept of the number of times and the amount the helm is shifted. It is proposed to add clockwork mechanism, so that the paper will be continuously unwound at a uniform speed, and the time at which any movement is made will thus be recorded.

Model of the Moon. Field Columbian Museum. (Diameter, 19 feet.)

ONE of the most interesting additions to the Field Columbian Museum in 1898 was the Schmidt-Dickert relief model of the moon, an illustration of which we are enabled to give by the courtesy of Mr. F. J. V. Skiff, the director of the museum. The model is in the form of a hemisphere having a diameter of 19 feet, and it exhibits very accurately the surface features of the moon. It was prepared with great care from the charts of Beer and Madler, and of Dr. Schmidt, of the Athens Observatory. Five years were occupied in its construction. The sections of the model have been for several years in Chicago, but they have only been available to the public at rare intervals. It is through the generosity of Mr. L. W. Reese that this noteworthy object has been added to the collections in the Field Columbian Museum. The model as exhibited will undoubtedly prove of great interest to the public generally, and especially to students of astronomy. Chicago is fortunate in possessing such a striking representation of lunar topography.

THE absence of palæolithic implements from Scotland has been explained by glacial conditions or the submergence of the country. Neither of these explanations seems to the Rev. F. Smith to be adequate, for during part at least of the period in question (as during the deposition of the *Cyrena fluminalis* beds) the climate of Britain was warmer than it is now, and the geographical occurrence of palæolithic remains in England and France evidence the period to have been that of great upheaval, and it is improbable that Scotland was then submerged. He finds (*Proc. Philosoph. Soc.*, Glasgow, 1899) a more sufficient explanation in the suggestion that the searchers were looking for the wrong thing. The ordinary types being flints, flint specimens were sought in Scotland; but no flint exists *in situ* in Scotland. Either palæolithic man was limited in his habitat to the geographical occurrence of flint, or that such specimens as might exist in Scotland would be fashioned of the rocks native to the country, and would be lacking in the peculiar characteristics of flaked flint. The first assumption is probably erroneous, so Mr. Smith has spent many years to an investigation of the alternative proposition. Under analogous conditions to those which obtain in the Somme Valley, he has found in the valleys of the Forth, Tay, Earn, Allan, Dee and Don, and in the Clyde Estuary, stones of quartzite, basalt, and various igneous rocks which certainly bear a superficial resemblance to well-known palæolithic types. The author acknowledges that these stones can only be fully appreciated by being handled, and that his illustrations do not do them justice. The author's contention is certainly tenable, but the evidence of the specimens can only be gauged by actual inspection.

THE origin of religion has long been a difficult problem, and is likely to remain obscure for some time yet. The germ, according to Tylor, lies in the belief in spiritual beings; Lippert finds it in the worship of the soul. Herbert Spencer has stated that ancestor worship is the root of every religion, and again that there is strong warrant for the inference that ghost-propitiation is the origin of all religions. C. L. Henning attempts in *The American Anthropologist* (vol. xi. p. 373) to solve the question from quite another standpoint. All the investigators in this field, without exception, have neglected one principal factor in their respective researches—the economic conditions. Primitive man had no religion; this was the product of much later times, and did not arise from a so-called "religious sentiment." A system of social virtues, or in other words a primitive social morality, was early developed owing to men being united in hordes; but this has nothing to do with religious perceptions. A man who during his life ameliorated the economic conditions of his tribal companions was not forgotten after his death; of this there are innumerable past and present examples. Such men after their death became heroes or benefactors of their respective tribes. The veneration they enjoyed during life changed after their death into ancestor worship, and later on into soul worship; the two latter forms of worship are the beginning of the historical evolution of religion.

THE Geology and Agriculture of the Department of the Lozère, in the south of France, forms the subject of an elaborate article by M. Ernest Cord (*Bull. de la Soc. d'Encouragement pour l'Industrie Nationale*, Paris). In the second part of his work, published in April, the author gives an account of the Triassic and Liassic strata. The Trias, which consists mostly of sandstones and conglomerates, with some argillaceous layers, occupies small tracts of woodland with fine chesnut-trees and much oak coppice. The central plateau of the Lozère, consisting of gneiss, mica schist, and granite, is bordered by Jurassic rocks which formerly overspread this group of ancient rocks. From the Rhætic Beds to the Upper Lias the various stages are well represented. Much of the soil on the Rhætic formation is a kind of arkose, derived from granitic débris in the strata, and it is dry and sandy; nevertheless there are calcareous ingredients, and the beech flourishes. The higher portions of the "Infra-Lias" and the Lias proper consist mainly of limestones, marls and clays, and they form a rich agricultural district—cereals, vegetables and fruit being cultivated. Attention is directed to the magnesian limestones, which form striking features in the upper part of the "Infra-Lias." These limestones are much fissured, and the streams in many instances pass underground and reappear at lower levels. Several illustrations of these swallet-holes are given. The magnesian waters have an injurious effect on those who are accustomed to drink them, and it is noted that goitre is met with among the residents in these districts.

IN the *Verhandlungen der k. k. geol. Reichsanstalt*, No. 2, 1899, some results of recent geological work in southern Dalmatia are described by G. Bukowski. In the region examined, the tectonic relations were found to be of a very complex character, and overfolding and overthrusting have occurred upon an enormous scale. This may be well understood when it is said that the Hallstadt limestones, forming the base of the series observed, are overlain by Cretaceous and older Tertiary rocks, to be followed in turn by Triassic Dachstein-limestone. In places, the Tertiary beds have become completely squeezed out, in which case the Dachsteinkalk rests directly upon the Cretaceous limestones. In the region of southern Pastrovicchio, the upper beds of the *Diplopora*-limestone have yielded a brachiopod-fauna peculiar for its richness in species and individuals of *Spirigera*. In the upper Triassic limestones, a marked change of facies is apparent. The tufaceous complex of the Dzurmani-beds is overlain by rocks having a Hallstadt cephalopod-facies, which yields in turn, in the higher beds, to a coral-reef facies.

TO the *Verhandlungen der k. k. geol. Reichsanstalt*, No. 3, 1899, Dr. J. J. Jahn contributes a short paper on the occurrence of moldavite (bouteillenstein) in the pyrope-bearing sands (early Diluvial) of northern Bohemia. After describing specimens found at localities west of Trebnitz, the author gives a summary of the results of experiments carried out by Herr Jos. Bareš, who has investigated the behaviour of moldavite when subjected to very high temperatures, with a view to clearing up the question of its origin. From a comparison of the chemical composition and physical properties of serpentine and moldavite, the hypothesis that the latter has had its origin in the former, as held by Helmhacker, derives no support whatever. By experiments carried out with various kinds of glass, and a comparison of the behaviour of these and of moldavite at temperatures ranging up to 1400° C., as also by a comparison of the chemical composition of the respective substances, Bareš obtains strong evidence against the correctness of the theory that bouteillenstein is an artificial product of glass manufacture. Further experiments refute also the hypothesis that moldavite may have been produced, by the aid of volcanic activity, from felspar-bearing rock rich in silica. From a consideration of the form and surface structure of the various specimens, and their behaviour under the highest temperatures, Herr Bareš agrees with Dr. F. E. Suess in recognising the probability of a cosmic origin.

THE May number of the *Zoologist* contains a very interesting account by Mr. Cronwright Schreiner on the recent extraordinary "trek" of Springbuck in the Cape Colony. The vast number in which these antelopes migrated in former years is a familiar fact; but in recent times they were believed to have ceased for ever. All the more remarkable, therefore, is it to hear of the great "trek" which occurred in July 1896. On the occasion when he saw the largest herd, Mr. Schreiner believes that there

were at least half a million antelopes in sight at once; and from this it is inferred that the whole "trek" must have included millions. Of course, thousands of head fell to the rifles of the Boer and other hunters; and a brisk trade sprang up in hides and meat. The writer of the paper infers that a migration on such a scale will never be seen again, for the reason that the Springbuck will be unable to recruit their numbers to a sufficient degree.

WE are asked to announce that the second annual dinner of the Association of Old Students of the Central Technical College will be held on Thursday, July 6.

THE *Quarterly Journal of Microscopical Science* contains two papers by Mr. J. E. S. Moore, dealing with his researches on the Molluscs of the great African lakes, especially Tanganyika. In the first paper, which discusses the morphology of the two littoral forms *Tanganyikia* and *Spekia*, the most interesting relates to the ancestry of the terrestrial *Cyclophoridae*. It is suggested that they trace their origin from some fresh-water derivative of the Tanganyika genus *Purpurina*, such as the cretaceous *Pyrgulifera*, which may represent a fresh-water non-halolimnic development of the type. The second paper deals with the truly halolimnic genera *Nassopsis* and *Bythoceras*. In regard to these and allied types, the author makes the following concluding observations. "We have the wonderful similarity of the halolimnic shells now living in Tanganyika to those which have been left fossilised at the bottom of the old Jurassic seas; and, lastly, there are the morphological characters of the halolimnic animals themselves, whereby they become mentally depicted like nothing so much as the incompletely developed embryos of numerous living oceanic types."

A COPY of volume x. of the *Transactions* of the American Pediatric Society, edited by Dr. Floyd M. Crandall, has been received. A number of papers and reports on infantile diseases are contained in the volume, one of the most important being a statement of the results of the Society's collective investigation on infantile scurvy in North America.

"A Select Bibliography of Chemistry" (1492–1892), by Prof. H. Carrington Bolton, was published in 1893. The first supplement of this volume, including words omitted in the previous volume, and bringing the literature of chemistry down to the close of the year 1897, has just been issued as No. 1170 of the Smithsonian Miscellaneous Collections. The sections into which the titles are grouped are: bibliography, dictionaries, history, biography, chemistry (pure and applied), and periodicals, the titles being in each case arranged alphabetically according to authors. The section dealing with alchemy has been dropped. The number of titles in the original volume was 12,031, and the number in the present volume is 5554, making a total of 17,585. Germany comes first in the number of additional titles, with a total of 1461. France follows with 1085 titles, England with 972, and Russia with 581 titles. The next six countries in order of their number of contributions to chemical literature are: Iceland, 434; Sweden, 196; Holland, 191; Denmark, 151; Portugal, 123; Bohemia, 98.

A COMMENDABLE characteristic of the report of the Marlborough College Natural History Society is a collection of anthropometrical particulars referring to boys in the school, obtained by Mr. E. Meyrick. The measurements are a continuation of records published last year. For each boy the information tabulated is his form, age, height, weight, size of chest expanded and contracted, and where possible the increase compared with last year's measures. Information of this kind is of real service to students of physical anthropology. Among other noteworthy matters in the report is a list of 417 wild flowering plants observed by members of the botanical section, one member, Mr. F. E. Thompson, having obtained no less than 189, a worthy conclusion on his part to a series of botanical observations extending over thirty years. Appended to the usual meteorological statistics for every day of 1898 is a summary of the meteorology of Marlborough for the ten years 1889–1898. In addition, the report contains sectional reports, notes and observations, notes on lectures, and a variety of other information—all instructive and of interest as showing the development of the scientific spirit in a public school.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*, ♀) from West Africa, presented by Dr. H. Strachan; a Rufous Tinamou (*Rhynchotus rufescens*) from Brazil, presented by Mr. Henry Bell; a Common Kingfisher (*Alcedo ispida*) from Ireland, presented by Mr. Ronald Edwards; two Jackdaws (*Corvus monedula*, white var.), European, presented by Mr. Eardley Wilmot B. Holt; two Secretary Vultures (*Serpentarius reptilivorus*) from South Africa, presented by Mr. J. E. Matcham; two Green Turtles (*Chelone mydas*) from the Gulf of Manor, presented by Captain Geo. G. C. Stevenson; two Black-striped Wallabies (*Macropus dorsalis*, ♂ ♀) from New South Wales, two Stonechats (*Pratincola rubicola*) from South of France, two Derbian Parrakeets (*Palaeornis derbyana*) from China (?), a South Albemarle Tortoise (*Testudo vicina*) from South Albemarle Island, deposited; a Musk Duck (*Biziura lobata*) from Australia, three Barbary Turtle Doves (*Turtur risorius*) from Africa, a Tuatera Lizard (*Sphenodon punctatus*) from New Zealand, purchased; two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A.	Decl.	Br.
	h. m. s.	° ′	
June 8 ...	15 59 12 ...	+ 46 18·1 ...	0·88
9 ...	48 32 ...	44 39·5	
10 ...	39 2 ...	43 2·2 ...	0·75
11 ...	30 32 ...	41 27·2	
12 ...	22 56 ...	39 54·7 ...	0·63
13 ...	16 5 ...	38 25·4	
14 ...	9 57 ...	36 59·3 ...	0·53
15 ...	15 4 27 ...	35 36·6	
16 ...	14 59 29 ...	34 17·3 ...	0·45
17 ...	54 57 ...	33 1·3	
18 ...	50 51 ...	31 48·7 ...	0·38
19 ...	47 7 ...	30 39·7	
20 ...	14 43 45 ...	+ 29 33·4 ...	0·32

Being now almost two months past perihelion, the comet is rapidly becoming less conspicuous. During the week it will pass from Herculis into Bootis, its path being nearly parallel to a string of 4th mag. stars ϕ and χ Herculis, μ, δ and ϵ Bootis.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last (June 3), the Astronomer Royal presented his Annual Report to the Board of Visitors of the Royal Observatory, Greenwich. The weather was all that could be desired, and the large number of guests, numbering among them Prof. Cornu, was able to comfortably inspect the buildings and instruments, which had as usual been thrown open to view.

The following is a brief *résumé* taken from the report:—

Buildings.

The new Observatory building, which has been in progress since 1891, was completed last March, by the addition of the east and west wings. This handsome building provides much needed accommodation for the Observatory staff, for the photo-

graphic records and books of calculations, and for the library, which had long outgrown the rooms hitherto available for it. In the new Observatory building—which is cruciform in shape, having four wings of three stories, with a central tower carrying the Thompson equatorial and dome—the staff occupies the principal floor, the library will be placed in the ground floor of the north, east and west wings, the ground floor of the south wing being fitted up as a workshop, and the upper floor will accommodate the photographic and other records and the stock of publications of the Observatory.

The completion of the new Observatory building, which at three points breaks into the existing boundary fence, makes it desirable that the boundary of the Observatory should be enlarged in order to show off the handsome new building, and a proposal to give effect to this is under the consideration of the Admiralty.

The new Magnetic Pavilion, in an enclosure in Greenwich Park, at a distance of about 350 yards from the Observatory, on the east side, was completed at the end of last September, and the magnetic instruments for absolute determinations have been installed there. The greatest care has been taken to exclude all iron in building the Magnetic Pavilion, and the site has been selected so that there is no suspicion of magnetic disturbance from iron in the neighbourhood. The enclosure also provides a good meteorological station, where the standard thermometers and rain-gauges have been mounted.

Transit Circle.

The sun, moon, planets, and fundamental stars have been regularly observed on the meridian as in previous years. The number of observations made from 1898 May 11 to 1899 May 10, was as follows :—

Transits, the separate limbs being counted as one observation	11,764
Determinations of collimation error	298
Determinations of level error	694
Circle observations	10,830
Determinations of nadir point (included in the number of circle observations)	665
Reflection observations of stars (similarly included)	560

The number of stars observed in 1898 was about 5000.

The number of meridian observations in the first three months of 1899 was unusually large, being 1200 more than the average of the three preceding years. The excess was entirely in January and February, for which months the number of observations was double the average number. This unusually large number of observations has caused great pressure on the computing staff in that branch, and it is much to their credit that the reductions have fallen so little behind.

The apparent correction for discordance between the nadir observations and stars obtained by reflection for 1898 was found to be $0''\cdot36$. The results of recent years are as follows :—

	Mean	Range	
	$''$	$''$	$''$
1880-1885	$-0\cdot34$ from	$-0\cdot29$ to	$-0\cdot45$
1886-1891	$+0\cdot03$ from	$-0\cdot12$ to	$+0\cdot09$
1892-1898	$-0\cdot30$ from	$-0\cdot25$ to	$-0\cdot36$

New steel screws for the microscope micrometers were introduced in 1886, and in October 1891 the object-glass was repolished, and a new steel telescope micrometer screw was introduced.

Both microscope and telescope micrometer screws have been examined, but show no errors which would account for this discordance.

The co-latitude of the transit-circle, as found from observations of about 600 stars in 1898, is $38^\circ\ 31'\ 21''\cdot75$, differing by $-0''\cdot15$ from the adopted value. The effect of Chandler's latitude variation was computed for each of these stars within the limits 10° and 35° N.P.D. The table, which is given in the Report, exhibiting the effect of Chandler's correction to the colatitude on the means of groups arranged for each hour of right ascension, shows how entirely its influence is eliminated from the resulting co-latitude.

The mean error of the moon's tabular place (computed from Hansen's lunar tables with Newcomb's corrections) is $-0\cdot143$s. in R.A. and $+0''\cdot14$ in N.P.D. deduced from 104 observations. These are equivalent to an error of $-2''\cdot23$ in longitude and $+0''\cdot21$ in ecliptic north polar distance.

In the last Report, the equivalent error in longitude was $-1''\cdot97$ and $+0''\cdot16$ in ecliptic north polar distance.

From June to December 1898 a new determination of the division errors of the transit-circle was made by Mr. Dyson and Mr. Thackeray. An account of this investigation has been published in the *Memoirs* of the R.A.S., vol. liii., so that we need not refer again to it here.

The New Altazimuth.

After the date of the last Report, it was found that the readings of the several microscopes varied systematically with the direction in which the instrument was swung. As this pointed to a constraint in the axis, several modifications were made in different parts of the instrument. These various changes were not completed till February 23, and since then the observations, both of transits and zenith distances in reversed positions, show a satisfactory accordance.

Among the observations made with this instrument may be mentioned 1017 R.A. observations of the sun, planets and stars, 961 N.P.D. observations of the same bodies, and 20 observations in R.A. and N.P.D. of the moon.

Thompson Equatorial.

The return of the object-glass of the 26-inch refractor on 1898 May 16 is referred to in the last Report. Slight figuring of the outer surface under Sir Howard Grubb's direction was continued till June 8. The object-glass was further tested by photographs taken inside and outside of focus and with diaphragms, and was finally approved in September. The new 30-inch mirror, of slightly shorter focal length (corresponding to the length of the tube), was received from Dr. Common on September 1. Photographs to test the mirror were taken in the principal focus and also in the secondary focus, and it was found to be quite satisfactory.

With the 26-inch refractor, twelve successful photographs of Neptune and its satellite have been obtained, using the occulting shutter to screen the planet during the greater part of the long exposure necessary to show the satellite, a series of short intermittent exposures for the planet being given by lifting the arm of the shutter. The results of these observations are given in the *Monthly Notices of the Royal Astronomical Society*, vol. lix., May. Forty-two successful photographs of sixteen double stars have also been obtained, including six of Aldebaran, for which the occulting shutter was used in order to obtain measurable images of Aldebaran and the faint companion, for which a 20m. exposure was required. A few photographs of fields of stars have also been obtained.

With the reflector, thirty-two photographs of the planet Eros were obtained between September 20 and March 31, nine photographs of Neptune and its satellite, four of Comet Brooks, and one of Comet Tuttle. To investigate the distortion of the field, five photographs of the Pleiades have been taken.

With an exposure of an hour, a "fine photograph of the Andromeda nebula has been obtained."

28-inch Refractor.

This instrument has been used throughout the year for micrometric measurements of double stars. Four hundred and ten stars have been measured ; 206 of these have their components less than $1''\cdot0$ apart, and 87 less than $0''\cdot5$. The stars the distance apart of which is less than $1''\cdot0$ have been measured on the average on three nights each, and the wider pairs on two and a half nights. The wider pairs measured consist of stars in which there is a considerable difference of magnitude between the components, of third companions to close pairs, and of stars which are of special interest.

A long series of measures of 70 Ophiuchi has been obtained.

Astrographic Equatorial.

During the year ending 1899 May 10, 465 plates have been taken on 120 nights. Of these 78 have been rejected, viz. 34 because the exposure was interfered with by cloud, or because the images were too faint to show 9th magnitude stars with a 20s. exposure ; 17 owing to faults in guiding or exposure ; 8 on account of wrong setting ; and 19 from miscellaneous defects.

The following statement shows the progress made with the photo-mapping of the heavens :—

	For the Chart (Exposure 40m.).	For the Catalogue (Exposures 6m., 3m., and 20s.).
Number of photographs taken ...	256	... 200
,, successful plates ...	211	... 167
,, fields photographed successfully	206	... 160
Total number of successful fields reported 1898 May 10	828	... 909
Number of photographs, previously considered successful, rejected during the year	7	... 39
Total number of successful fields obtained to 1899 May 10 ...	1027	... 1030
Number still to be taken	122	... 119

Of the 122 fields to be photographed, 101 are within 7° of the pole. The photography of this part of the sky was purposely deferred till near the epoch 1900, and has just been begun.

In last year's Report, we mentioned that 166 catalogue plates out of 909—that is, nearly one-fifth of the total number—and 90 chart-plates out of 828, had deteriorated owing, probably, to the effect of damp in the building in which they have to be stored pending the completion of the new physical laboratory.

This year we read that the deterioration of some of the plates has continued, as it was not found practicable to move the photographs into the new Observatory building till March. Besides the plates which have been rejected during the year, as mentioned in the tabular statement above, there are about forty catalogue plates in the zones yet to be measured which should be taken again. The damaged chart-plates have all been copied, and the positives on glass will in any case be available. But it seems advisable that all the damaged plates, whether measured or copied, should be replaced by others, and, as the photo-mapping for the zone allotted to Greenwich is now nearly completed, this work can shortly be taken in hand.

Heliographic Observations.

In the year ending 1899 May 10, photographs of the sun have been taken on 195 days, either with the Dallmeyer or Thompson photo-heliographs. The former, mounted on the terrace roof of the south wing of the physical observatory, was used as the regular instrument for solar photography up to and including 1898 July 27, when the Thompson 9-inch photo-heliograph was substituted for it. The Dallmeyer photo-heliograph was dismounted and placed in the upper floor of the museum on 1898 October 13. Of the photographs taken with either instrument, 394 have been selected for preservation, besides sixteen photographs with double images of the sun, for determination of zero of position-angle. Photographs to supplement the Greenwich series have been received from India and Mauritius up to 1899 January 13.

For the year 1898, Greenwich photographs have been selected for measurement on 165 days, and photographs from India and Mauritius (filling up the gaps in the series) on 192 days, making a total of 357 days out of 365 on which photographs are at present available. No photographs have been received from Mauritius of later date than 1898 August 7, and as the eight days which are at present unrepresented are all since that date, it is possible that the record for the year may yet be rendered complete.

The chief incident in the history of the sun's surface, during the period covered by this Report, was the very remarkable temporary revival of activity which set in at the end of July and lasted almost to the middle of November, culminating in the appearance of the great group of September 3–15. Apart from this, the sun's surface has been very quiet during the year, the spots being few, isolated, and small. There have, however, been no such long-continued instances of the entire absence of spots as to suggest that the minimum had been actually reached or is immediately at hand, the number of days without spots for which a record is at present available being 49, as compared with 42 in the previous Report.

Magnetic Observations.

The variations of magnetic declination, horizontal force, and vertical force, and of earth currents, have been registered photographically, and accompanying eye observations of absolute declination, horizontal force, and dip have been made as in former years.

On the completion of the new Magnetic Pavilion, last September, the Gibson deflection instrument and the Airy dip-circle were mounted there, and regular determinations of magnetic horizontal force and dip have been made there from that time.

The principal results for the magnetic elements for 1898 are as follows:—

Mean declination ... ... 16° 39′·2 West.

Mean horizontal force ... { 3·9878 (in British units). { 1·8387 (in Metric units).

Mean dip { January to June 67° 12′·4 } { October to December 67° 11′·3 } (with 3-inch needles).

These results depend on observations on the site of the Magnetic Pavilion, and are free from any disturbing effect of iron. The correction to the declination, as found in the Magnet House, is −10′·7, deduced from the observations with the Elliott declinometer, in September and October, and with the new declinometer in the Magnetic Pavilion, the values found with the two instruments being precisely the same.

The question of the protection of the Observatory from disturbance of the magnetic registers by electric railways or tramways in the neighbourhood has caused much anxiety during the past year. A number of such railways are now projected, and the value of the magnetic registers, which have now been carried on continuously for nearly sixty years, will depend entirely on the conditions under which electric traction is used. Steps have been taken, in concert with Prof. Rücker, acting on behalf of Kew Observatory, to have a special clause inserted for the protection of Greenwich and Kew Observatories. This has already been accepted in several cases, and it is hoped that it will be agreed to in others where necessary.

Meteorological Observations.

The mean temperature of the year 1898 was 51°·3, being 1°·8 above the average for the fifty years 1841–1890. During the twelve months ending 1899 April 30, the highest daily temperature in the shade recorded in the open stand was 92°·1 on September 8. The highest reading recorded in the Stevenson screen was 90°·0 on the same day.

The monthly mean temperatures were in excess of their corresponding averages from August to February (inclusive) to the mean amount of 3°·9. In December, the excess amounted to 6°·1, and in September to 4°·9. In the five remaining months of the year the mean temperatures were below the average values.

The mean daily horizontal movement of the air in the twelve months ending 1899 April 30 was 291 miles, which is ten miles above the average for the preceding thirty-one years. The greatest recorded movement was 950 miles on January 21, and the least 67 miles on March 14. The greatest recorded pressure of the wind was 33 lbs. on the square foot on February 13, and the greatest hourly velocity 53 miles on January 12.

The number of hours of bright sunshine recorded during the twelve months ending 1899 April 30 by the Campbell-Stokes instrument was 1500 out of the 4454 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·337, constant sunshine being represented by 1.

The rainfall for the year ending 1899 April 30 was 22·74 inches, being 1·80 inches less than the average of fifty years. The number of rainy days was 158. The rainfall in the month of September amounted to 0·305 inch, being the smallest September rainfall on record in the period 1841–98, with the exception of September 1865, when the rainfall was only 0·16 inch.

Longitude of Killorglin.

The longitude of Killorglin, at the head of Dingle Bay, Ireland, was determined in October and November. The station was selected in order to eliminate, as far as possible, the effect of local attraction at Valentia and Waterville, both of which longitude stations are situated between the Atlantic on the west and a mountain mass on the east.

A desire has been expressed by the International Geodetic Association for a re-determination of the longitude of Paris—Greenwich in view of the discordance in the results found by the French and English observers respectively in the two de-

terminations in 1888 and 1893, and the Council of the Paris Observatory have recommended that this work should be undertaken in concert with Greenwich Observatory. As a preliminary to the actual longitude operations, it seems essential that the instruments to be used by both parties of observers should be thoroughly tested at contiguous stations.

SPURIOUS EARTHQUAKES.

IN compiling the seismic record of any country, we are liable to errors from two sources. We cannot help omitting a large number of slight earthquakes, which it is difficult to separate from the countless tremors that are artificially produced. On the other hand, we include a smaller, but still important, number of shocks which are not seismic in their origin, though they simulate earthquakes in many ways. Errors of the former class are, of course, difficult to prevent, though they tend to become less frequent when attention is given to the subject. Those of the latter class may sometimes be eliminated by a study of the different kinds of disturbance which have been, or might be, mistaken for true earthquakes.

The majority of spurious earthquakes in this country are produced by the firing of heavy guns, the bursting of meteorites, and the fall of rocks in underground channels. Explosions and landslips produce disturbances which are at first frequently mistaken for earthquakes, but their real origin cannot fail to be soon discovered and remembered. Perceptible tremors are also produced in buildings by thunder, but it is improbable that permanent errors can thus arise, for the long duration of the sound, in conjunction with the small area affected, provides a simple test. I shall, therefore, confine myself to the first three causes mentioned in this paper.

FIRING OF HEAVY GUNS.

The sound and tremor produced by the firing of heavy guns are sometimes perceived at great distances; but, as I propose to deal with this subject in another paper, I will merely mention here that observations of the sound at distances exceeding one hundred miles are by no means uncommon.

On two or three occasions within the last few years I have been able to trace supposed earthquakes to this source. On the first (January 7, 1890), two shocks were felt in the south-west of Essex at 12.30 and 1.25 p.m. All the places from which I received accounts lie close to a line running north-east from Woolwich, with one exception, in which the direction is north by east. I have no report of the direction of the wind in the immediate neighbourhood, but southerly and south-westerly breezes were generally prevalent over the whole country on that day. Near the boundary of the district affected, the disturbance was supposed to be seismic by observers who felt the Essex earthquake of 1884: somewhat nearer the origin, the sound resembled the report of a heavy gun; while, six miles from Woolwich, the noise and shock were referred without hesitation to their true cause, the discharge of a 110-ton gun at Woolwich at the times mentioned.[1]

On May 5–6, 1893, a number of shocks were felt at nearly regular intervals in the Isle of Man. At Douglas, where they were very slight, they were regarded as earthquakes; further south, at and near Castletown, they were described as resembling the reports of heavy guns, but the likeness was not striking enough to raise doubts as to their seismic character when it was once asserted; at the Chickens Lighthouse, off the extreme southern point, the keeper informed me that no earthquakes were felt, but that there must have been some man-of-war practising to the south-south-west; and this, on inquiry at the Admiralty, was found to have been the case, H.M.S. *Neptune*, a first-class battle-ship, having been engaged in heavy-gun practice to the south of the island during the very times when the reported earthquakes were heard and felt.

Tests.—The principal tests by which the true character of these disturbances may be distinguished are the following: (1) When several are noticed on one day, they are of not very unequal intensity, and may occur at nearly regular intervals. (2) The disturbance is apparently communicated through the air. (3) The gradually increasing confidence in one direction with which the shocks are attributed to gun-firing is no doubt the most important test. (4) In many cases, the position of the disturbed area or the time of occurrence may lead to suspicions regarding the seismic nature of the shocks. (5) If the disturbed area were extensive, a few good time-observations would give a velocity approximating to that of sound-waves in air.

[1] The supposed earthquake at Chelmsford on January 7 (NATURE, vol. xli., 1890, p. 369).

THE BURSTING OF METEORITES.

The explosive bursting of meteorites is one of the commonest causes of spurious earthquakes. The mistake in such cases, it is probable, arises not so much from any close similarity between the two phenomena, as from the exclusion in the minds of the reporters of all artificial causes, and the consequent inference of a seismic origin. The explosion of a large meteor, weighing one or several tons, on entering the atmosphere is heard, according to the late Prof. H. A. Newton, for "a hundred miles around, shaking the air and the houses over the whole region like an earthquake." (NATURE, vol. xxxiv., 1886, p. 533). Many such cases might be quoted, and a very large number must be known to those who have made a special study of the subject, but the following are probably sufficient for the present purpose.

West of England Meteorite, January 25, 1894.—At an early stage of its flight, this meteor, according to Mr. Denning, passed over Chester at a height of fifty-eight miles. It travelled in a direction from N.N.W. to S.S.E., passing almost over Droitwich and Worcester, at a height of about twenty-three miles, and disappearing with an explosion when about sixteen miles above a point four miles north of Ashchurch (near Tewkesbury). Two minutes after its disappearance three detonations were heard at Worcester, "the last being of exceptional violence, shaking buildings and causing the earth to vibrate." At Brinscombe (near Stroud), about a minute or a minute and a half after its disappearance, "there came (apparently from the north-east) a series of explosions, which sounded . . . like a number of field-pieces fired in rapid succession, followed by a volley of musketry." One of the most interesting observations from the present point of view is that made by an observer at Parkfields (near Ross). "A slight earthquake," he says, "was felt here. . . . I heard a loud rumbling noise like an explosion, lasting two or three seconds, which I took for thunder. A young lady who had just gone up to her room tells me that there were two slight shocks, the motion being similar to that of a steamer at sea. . . . I am informed that it was accompanied by a lurid light, which lasted some time, and that objects at a considerable distance were plainly visible. The night was dark and cloudy, with some rain." The recorded observations are too few in number to determine the boundaries of the sound-area and disturbed area, but a perceptible tremor was felt at Alvechurch (near Redditch), which is thirty-nine miles from Ross, and the sound was heard at Alvechurch and Brinscombe, places which are forty-four miles apart.[1]

Central England Meteorite, November 20, 1887.—At about 8.20 a.m. a loud sound, accompanied in many cases by a distinct trembling or shaking of houses, was heard over a large area, chiefly in the counties of Cambridge, Bedford, Hertford, Buckingham, Oxford and Berkshire. Many observers at once attributed the phenomena to an earthquake, and Mr. H. G. Fordham, who has made a careful study of them,[2] commenced his inquiries under that impression. It soon appeared, however, that the disturbance proceeded from the air rather than from the ground, and this fact, together with the actual observation of a meteor at the time mentioned, placed its true origin beyond doubt.

The accompanying map is, in part, a reproduction of that prepared by Mr. Fordham; but my object being somewhat different from his, I have added some details and omitted others. Every place where the sound was heard without any mention being made of an accompanying tremor is denoted by a small cross. If the concussion was strong enough to make doors, windows, and other loose objects rattle, the place of observation is shown by a large dot; if the tremor only is mentioned, without any other indication of its intensity, it is marked by a small dot. The sound-area as thus drawn is about 105 miles in length and nearly forty miles in breadth.

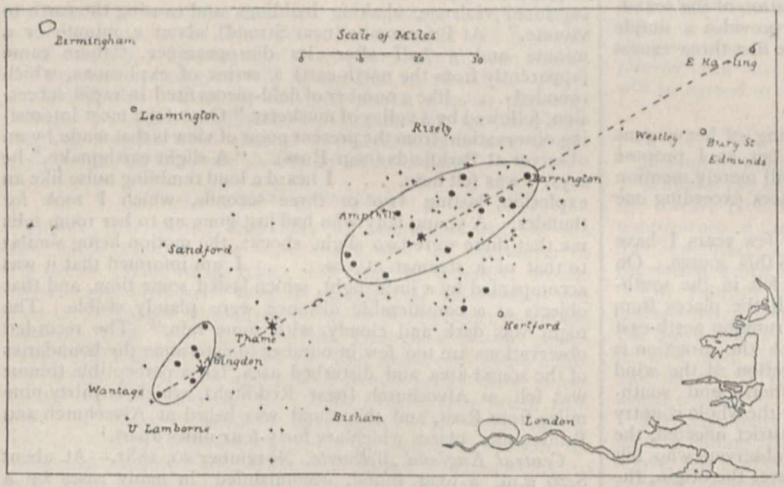
From the grouping of the places, where the sound was especially loud and definite, Mr. Fordham believes that the track of the meteorite would probably be best defined by a line drawn from Barrington (near Cambridge) to Wantage. Assuming this line

[1] NATURE, vol. xlix., 1894, pp. 324–325; *The Times*, January 29, 31, 1894.
[2] The meteorite of November 20, 1887.—*Hertfordshire Nat. Hist. Soc. Trans.*, vol. v., 1888, pp. 33–62.

to be correct, the observation of the meteor from Hertford would show that it was first seen when at a height of about thirty miles above East Harling, in the south of Norfolk, and that when above a point (indicated on the map by a star) about south-east of Ampthill, an explosion occurred which broke off part of the crust of the meteorite. At two other points (also marked by stars) in the neighbourhoods of Thame and of Abingdon and Wantage, explosions seemed to have occurred, the latter terminating the course of the meteorite.

Some additional evidence is furnished by the grouping of the places where the sound of the explosion was accompanied by a distinct tremor. The two dotted curves on the map bound all places (with two exceptions) where the concussion was strong enough to rattle doors, windows, crockery, &c. The form and dimensions of the larger of these curves show that the first explosion must have occupied an appreciable fraction of a second. One or, perhaps, two curves might be drawn surrounding the places from which tremors are recorded, but owing to the small number of such places between the dotted curves, it is uncertain whether it should be a single dumb-bell-shaped curve or two detached curves. It will be seen at a glance that the points which Mr. Fordham indicates for the Ampthill and Abingdon explosions lie very near the centres of the areas bounded by the dotted lines. The explosion above Thame was apparently too slight to produce any concussion on the surface of the ground.

Tests.—(1) The extremely elongated form of the disturbed area, and its great length when the slightness of the vibration is



taken into account; the detached isoseismal lines in those cases where there are two or more explosions. (2) The sound is far more prominent than the vibration, which is never the case all over the disturbed area of an earthquake unless that area is a very small one; also, the sound-area overlaps the disturbed area on all sides, and this is only the case with very weak earthquakes. (3) The character of the sound, often consisting of a series of explosions. (4) The obvious transmission of the sound-vibrations through the air. Though I have examined many thousands of earthquake-records, the sound is almost uniformly described by the writers as of underground origin. (5) The vibration of doors, windows, &c., is evidently a concussion due to the impact of air-waves. Occasionally a tremor is actually felt, but, as in the case of a heavy thunder-clap, this is no doubt due to the same cause. (6) The evidence of barograms may be useful in those cases where there is reason to believe that the movement is not due simply to the disturbance of the recording arm. (7) The actual observation of the meteor, or, if the sky be covered, of the glare of its light through the clouds.

ROCK-FALLS IN UNDERGROUND CHANNELS.

The fall of rock-masses in underground channels was for long regarded with favour as a possible cause of earthquakes.[1] No great and widely-felt shock would now be attributed to such a cause, but there are certain local earth-shakes which may reasonably be accounted for in this manner. The fall of a heavy mass of rock is evidently capable of producing the observed effects such as are described below. For example, towards the close of last century, one or more of the great upright stones of Stonehenge suddenly fell. According to Mallet, "the shock felt in all the neighbouring hamlets was so great that for some time, until the cause was discovered, it was thought to have been an earthquake, as in fact it was, though not produced by natural causes."[1]

Earth-Shakes in the Rhondda Valley.—In the Rhondda Valley in south-east Wales, there are frequent earth-shakes, which seem to be due to rock-falls in the deserted pit-workings by which the region is honeycombed. In many of the published accounts of these disturbances, there is evidently much exaggeration; but there can be no doubt that the shocks are sometimes strong enough to cause windows and doors to rattle loudly, and even to give rise to a distinct rocking sensation. The shocks are accompanied by a noise which is generally compared to the thud produced by the fall of a heavy body, or to the report of a colliery explosion or a distant gun. They also seem to be felt quite as severely in the mines as on the surface, and alarm the men at work, who naturally attribute the phenomena to an explosion. On a recent occasion (October 16, 1896), a miner, who was working in the Gelli pit, informs me that he heard one loud boom, like the discharging of a shot in rock, followed by a slight rumbling; "but others working in the same pit had a severe shaking, the tools springing off the floor, the dust rising in clouds off the bottom." Again, in the three cases (June 22, 1889; April 11, 1894; and October 16, 1896) which I have studied, the disturbed areas are roughly circular, and the diameters are small, being, respectively, about one, six and three miles in length; and the second of these is said to have been by far the strongest recently felt in the district. The centres of the three areas are close together, the two extreme ones being five miles apart, and they follow roughly the line of the Rhondda Valley. Now, the rapid diminution in intensity from the centre outwards implies a very shallow focus; the shock and sound are by nature such as would be produced by the fall of a heavy mass of rock, underground passages exist at no great depth, and subsidences at the surface are known to occur, for houses have been destroyed in this way in many parts of the district. The evidence in favour of the view that the so-called earthquakes are spurious is therefore strong; but the crucial test, that of finding the fallen mass, has, so far as I know, never yet been satisfied.

Earth-Shakes at Sunderland.—A similar, though less artificial, origin may be urged with equal force for the remarkable series of earth-shakes which are occasionally felt in and near Sunderland. These have been described and the theory of their origin clearly worked out in an admirable paper[2] by Prof. G. A. Lebour, from which the following details are taken. The disturbances consist of sudden shakes, strong enough to make crockery and windows rattle, often, but not always, accompanied by loud noises and dull rumbles. They are, moreover, singularly local, being almost entirely confined to the south-west part of the town, and, apparently, to certain linear bands within that part. As in the case of the Rhondda Valley shocks, the foci must be situated at slight depths, and the phenomena are such as would result from underground rock-falls. It is also certain that the necessary channels exist, for the magnesian limestone, on which Sunderland is built, is simply riddled with cavities of every size and shape, the origin of which is not far to seek. In the midst of the hardest and most compact portions of the limestone, there occur masses of soft pulverulent earthy

[1] I need not do more than refer to the subsidences in certain well-known districts which are almost entirely undermined by coal-pits or brine channels. The disturbance is sometimes described as resembling a severe earthquake, but there could hardly be more than a momentary confusion between the two phenomena.

[1] *Roy. Irish Acad. Trans.*, vol. xxi., 1848, p. 63.

[2] "On the Breccia-Gashes of the Durham Coast and some Recent Earth Shakes at Sunderland." (North of England Inst. of Min. Eng. *Trans.* vol. xxxiii., 1884, pp. 165–174.) See also *Geol. Mag.*, vol. ii., 1885, pp. 513–515.

matter, which are readily removed by the mechanica action of percolating rain-water. In such naturally-formed gullets run the feeders of water that are met with in sinking through the magnesian limestone, and these feeders, by chemical action, must cause much additional destruction of the rock. Quite apart from the water which runs off into the sea, that which is pumped up annually by the local water company is estimated to contain lime and magnesia in solution corresponding to nearly forty cubic yards of solid rock.

It seems evident that masses of rock must from time to time fall from the roofs of channels so formed. But we are not here left entirely to conjecture, for, at numerous points along the Durham coast, sections of such channels are exposed that are entirely filled up by angular fragments of the very rock which forms the cliff, and bound together by a cement of the same material. The "breccia-gashes," as they have been termed by Prof. Lebour, vary in width from a few feet to many yards; they are almost invariably narrow at the bottom, and generally wide at the top. "In some cases the broken fragments within the fissures can be traced graduating through semi-brecciated portions of beds to wholly undisturbed strata in the walls or fissure-cheeks. When the top of a fissure is exposed in section, the breccia is also seen usually to pass gradually upwards, first into semi-brecciated matter, and finally to undisturbed or only slightly synclinal beds bridging over the mass of broken rock. When the entire transverse section of a fissure is exposed, it is seen to be a deep V-shaped ravine or gullet, tapering to a point below, and the rocks below it are wholly undisturbed" (p. 166).

Tests.—Individual spurious earthquakes belonging to this class are the most troublesome of all to investigate, for, in most cases, we have to rely on circumstantial evidence alone. The principal tests will be obvious from the above descriptions. They are: (1) the small disturbed area and the comparatively great intensity near its centre; (2) the nature of the shock and sound; (3) the known or inferred honeycombed structure of the district, and the occurrence at other times of subsidences at the surface.

CHARLES DAVISON.

REPORT OF THE LONDON TECHNICAL EDUCATION BOARD.

THE annual report of the Technical Education Board of the London County Council was recently presented to the Council. The following paragraphs of the report, referring to the Board's relations with the Department of Science and Art and with the new London University, are abridged from the *Technical Education Gazette*.

Relations with the Department of Science and Art.

The Council has been recognised by the Department of Science and Art as the local authority responsible for science and art instruction within the area of the County of London in accordance with Clause VII. of the Science and Art Directory. The powers and duties which such recognition may give have been delegated by the Council to the Board in the same way as the powers conferred by the Technical Instruction Acts were delegated. Ever since the passing of the Technical Instruction Act in 1889, the Science and Art Department has been in the position of the central authority for technical instruction, and the county councils and county borough councils have been in the position of local authorities for technical instruction. Clause VII. introduced a certain readjustment of duties as between the central authority and the local authorities. No new powers are conferred outside the provisions of the Technical Instruction Acts, but the clause provides for some of the functions under those Acts which have hitherto been discharged by the central authority being delegated to the local authority. Over thirty counties and county boroughs have availed themselves of the clause, and it is stated by those who have had experience of the working of the new system that it is advantageous both to particular schools and to the district generally.

The principal benefits which the Board anticipates from the working of Clause VII. in London are the following:—

(*a*) Increased facilities for coordinating and organising science and art work in accordance with the particular needs of each locality.

(*b*) Greater regularity and promptitude in the payment of the grants earned on the Department's examinations.

(*c*) Increased opportunities for urging upon the Department such modifications in their courses of instruction as may be specially required by the circumstances of London schools and institutions.

The Technical Instruction Act of 1889 affords, perhaps, the first legislative example in educational work of adaptation to special local requirements. In the definition of technical instruction the Act includes "any other form of instruction (including modern languages and commercial and agricultural subjects), which may for the time being be sanctioned by that Department [the Department of Science and Art] by a minute laid before Parliament and made on the representation of a local authority that such a form of instruction is required by the circumstances of its district." The Technical Instruction Act having provided for the creation of powerful and disinterested authorities for the conduct and supervision of technical instruction over large areas, Parliament, in the words quoted above, expressed its willingness to give to these authorities an important part in determining the particular field of education which should come within their influence, thus enabling both the matter and the manner of education to be adapted to local needs. It is reasonable to suppose that the same principle will now apply in connection with the subjects of technical instruction which are defined by detailed syllabuses in the Science and Art Directory. The Department has already expressed its willingness to meet the wishes of the local authorities in respect of several administrative details.

The New University of London.

In order to formulate the Board's views with regard to the new University, a special sub-committee was last year established for the purpose of investigating the whole subject and reporting to the Board as to the steps which might be deemed necessary for making representations to the Commissioners on any points in which the Board might be specially interested. In pursuance of this policy, the Board forwarded to the Commissioners an expression of its views upon certain matters. In particular, the Board urged upon the Commissioners the desirability of recognising separate faculties for engineering and for economic and commercial science. The Board's representations were supported by similar expressions of opinion from other quarters, and the Commissioners have come to the decision to adopt the policy which the Board favoured. In the draft statutes which they have prepared for the new University, they have decided to provide for (*a*) a special faculty of engineering, and (*b*) a special faculty of economics and political science (including commerce and industry). There is little doubt that the establishment of these faculties will give considerable encouragement to the technical and commercial work in which the Board is specially interested. Recognising the importance of developing the higher departments of these branches of study, the Board has undertaken to allocate to the University out of the funds from time to time placed at its disposal by the Council an annual sum of 2500*l.* towards the maintenance of the faculty of engineering in the new University, and a further sum of 2500*l.* towards the maintenance of the faculty of economics and political science (including commerce and industry), on condition that satisfactory arrangements are made in the constitution of the University with regard to evening students, and the recognition and admission to th several faculties of duly qualified teachers in the polytechnics.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the speech delivered by the Public Orator, Dr. W. W. Merry, on the occasion of his presenting Dr. R. Trimen, F.R.S., for the honorary M.A. degree on May 16:—

Praesento vobis Ronaldum Trimen, Societatis Regiae Socium, nuper autem Societatis Entomologicae apud Londinium Praesidem. Vir insignis, qui notitiam suam officiosissime impertiendo de Universitate Oxoniensi optime meruit, diu in Africa australi est commoratus, non utique ut gemmas et aurum fodinis erueret neque ut cum Batavis litem sereret, sed ut Naturae arcana altius scrutaretur ac praesertim insectorum inexploratas consuetudines patefaceret.

"In tenui labor, at tenuis non gloria."

Quotus enim quisque mirum illud ingenium quo Natura inermes bestiolas instruxerit vel diligentius investigavit vel exposuit

luculentius? Quis clarius illustravit raram sollertiam qua minuta animalium genera, vel ut compares alliciant vel ut infestas hostium incursiones arceant, nunc colores mutare, nunc novum aliquod simulacrum assumere, nunc etiam sexum mentiri videantur? Quae quidem omnia si primo visu parvi momenti esse habeantur, eadem, nisi magnopere fallor, oculis subjecta fidelibus et summa accuratione tractata, immiane quantum prosunt ad intimas vitae leges enodandas. Quae cum ita sint, haud dubitarem eruditissimi auctoris C. Plinii Secundi verba citare de insectorum corporibus scribentis: "In his tam parvis atque tam nullis quanta vis, quae ratio, quam inextricabilis perfectio! . . . Sed turrigeros elephantorum miramur humeros, taurorumque colla et truces in sublime jactus, tigrium rapinas, leonum jubas, cum rerum natura nusquam magis quam in minimis tota sit; et in contemplatione naturae nihil possit videri supervacuum."

Praesento vobis ornatum et excultum virum Ronaldum Trimen, qui et ipse "Naturalis Historiae Libris" tam laudabile incrementum addidit, ut admittatur ad gradum Magistri in facultate Artium, honoris causa.

CAMBRIDGE.—Mr. W. Chawner, Master of Emmanuel College, is to be Vice-Chancellor during the ensuing academical year.

Mr. R. C. Punnett, of Caius College, has been nominated to occupy the University table at the Marine Biological Laboratory at Plymouth.

The Chemical, Pathological, and Anatomical Laboratories will be open during the ensuing Long Vacation, and a number of special courses of instruction will be given in July and August.

The electors to the new chair of Agriculture are the Right Hon. W. H. Long, Mr. A. E. Shipley, Dr. D. MacAlister, Prof. Liveing, Sir J. H. Gilbert, Prof. Foster, Prof. Marshall Ward, and Sir Walter Gilbey.

IT is satisfactory to know that the value of scientific education and research in agriculture is becoming more and more recognised by foremost agriculturists. Mr. Boyd-Kinnear refers to these matters in a contribution to the *Morning Post*, and to the lack of interest taken in them by British farmers. He points out that a knowledge of the scientific principles of agriculture is of fundamental importance, and that what should be taught in our schools are the sciences on which farming rests—physics, chemistry, mechanics, and the physiology of plants and animals. The sound remark is made that for a farmer to work without this kind of knowledge, is much the same as if a doctor were educated by being shown cases in a hospital before he had learned anything of anatomy or the nature of drugs. In order to know agriculture, it is necessary to understand first of all the elements and the action of the soil and the air, and the operations of life. But all that the most learned in science know of these things is infinitely small compared with the amount that is yet unknown. There is, therefore, urgent need, not only for teaching what is known, but also for learning more. That is, we ought to have both schools where the fundamental sciences which agriculture involves are taught, and also institutions for further research into the secrets yet undiscovered.

Referring to agricultural research stations, Mr. Boyd-Kinnear remarks:—In all countries but England these are provided and liberally maintained by the State. In Germany there are, and have been for the last half-century, no fewer than sixty-seven agricultural teaching and research stations. France has fifty-three, Austria thirty-five, and even Russia has fourteen. The other European States, including countries which we call so backward as Spain and Portugal, have sixty-one among them. The United States have fifty-four, these being supported by the individual States; Canada has several, while Brazil, Japan, and Java have each one! England has—none! none, that is, with State endowment. During the last few years, the County Councils of Sussex, Yorkshire, Bucks, and Durham have established teaching colleges, but without any adequate provision for research. There are also the privately-conducted colleges of Cirencester, Downton, and one or two others, while the half-century of inquiries conducted by Sir John Lawes is deserving of grateful acknowledgment. But isolated and private effort is wholly inadequate to meet the want, or even to direct public attention to it.

SOCIETIES AND ACADEMIES.

LONDON.

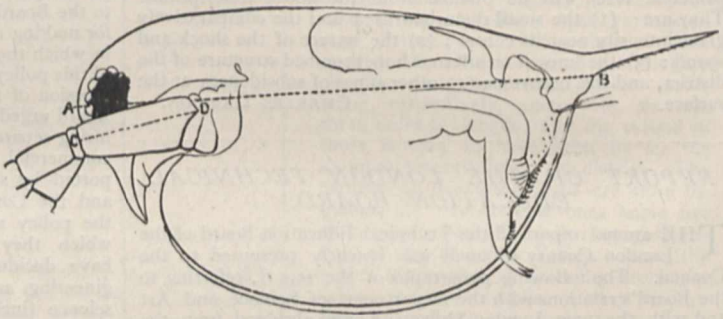
Royal Society, May 4.—"An Observation on Inheritance in Parthenogenesis." By Ernest Warren, D.Sc., University College, London. Communicated by W. F. R. Weldon, F.R.S.

If the hypotheses of Weismann on heredity and variation be founded on fact, then it should follow that offspring produced by parthenogenesis should exhibit little or no departure from their parthenogenetic mother.

It appeared an easy investigation to test this supposition by direct measurement. For this purpose, *Daphnia magna* (Straus) was chosen.

On twenty-three Daphnia, the following measurements were made: (1) the length of the protopodite of the second antenna of the right side (C D see Fig.), and (2) the total length of the body (A B). The first dimension was expressed in thousandths of the second, because these animals (like very many invertebrates) continue to grow throughout life. The broods, amounting in all to ninety-six young, produced by the twenty-three mothers (themselves originating by parthenogenesis), were similarly measured.

The children of the same parthenogenetic family were now seen to vary considerably. A correlation table between the mothers and offspring was prepared, and from it the coefficient of correlation was found to be ·466. The standard deviation (S.D.) of an array of offspring was 5·22 thousandths of the body length: if we express it as a kind of coefficient of variation we have $\frac{\text{S.D. of array}}{\text{Mean of all the offspring}} \times 100 = 3{\cdot}06$.



Thus *in parthenogenesis there is very considerable variability among the offspring*, but whether there is less or more than in sexual reproduction the present measurements do not show.

Dr. Galton and Prof. Pearson have shown that in Basset hounds, stature in man, &c., the correlation between father or mother and offspring approaches the theoretical value ·3, while between mid-parent and offspring it approaches ·424, and the coefficient of regression of offspring on mid-parent is about ·6.

Here, in the Daphnia, the coefficients of correlation and regression were respectively ·466 ± ·054 and ·619 ± ·081. Thus it would *seem* as though in the matter of inheritance a parthenogenetic mother acts as a mid-parent. The subject, however, requires much further elucidation, and the hypothesis is about to be tested on another parthenogenetic animal.

Geological Society, May 24.—W. Whitaker, F.R.S., President, in the chair.—The President called attention to the issue of vol. iii. of Hutton's "Theory of the Earth," and said that the thanks of the Fellows were due to Sir A. Geikie for having edited and annotated most carefully this work. The volume was printed from a previously unpublished manuscript which had been for many years in the possession of the Society: its contents were extremely interesting, and it supplemented the previous volumes by the inclusion of an index to the whole of the work, prepared by Sir A. Geikie.—Prof. Seeley exhibited a cast from a footprint obtained by Mr. H. C. Beasley from the Trias at Stourton. The impression is about 1½ inch long, and nearly as wide. The cast has been treated by oblique illumination, so as to display its osteological structure by means of the shadows thus thrown. All the claws are directed outwards, as in a burrowing animal. The form of the foot

resembles that of a monotreme mammal rather than that of any existing reptile. There appears to be a slender pre-pollex including three bones. The only other example of this structure in the Trias is in the Theriodont reptile *Theriodesmus*, in which it is less definite. This character may add to the interest of other footprints from Stourton, which in the form of the foot approximate to Anomodont reptiles from the Karoo Beds of Cape Colony.—On the distal end of a mammalian humerus from Tonbridge, by Prof. H. G. Seeley, F.R.S. The bone described in this communication was found in 1898 by Mr. Anderson on the bank of the river Medway, near Tonbridge. It was seen projecting from reconstructed rock which contained fragments of flints among other materials. Traces of matrix at the distal end show that the specimen has been derived from quartz-sand bound together with limonite, such as might occur in the Hastings Sand, Wealden Clay, or Lower Greensand. Conditions of mineral structure and osteological character incline the author to believe that the bone was originally contained in the Wealden Clay. The fossil is 4 inches long, and indicates a humerus which may have been 6 inches in length when perfect, as large as that of a wolf but smaller than that of a bloodhound. The form of the shaft precludes any comparison with the carnivora, and indicates a resemblance to ungulate types. When the bone is held vertically and seen from the front, the condyles are oblique—a character not observed in any other animal. The weight of evidence appears to incline towards reference of the fossil to the Artiodactyla, but it probably indicates a new family type.—On evidence of a bird from the Wealden Beds of Ansty Lane, near Cuckfield, by Prof. H. G. Seeley, F.R.S. A fragment of bone found, by Mr. Neville Jones, a member of the London Geological Field Class, embedded in sandstone was identified by the author as probably the distal end of the femur of a bird. The external condyle is not only larger and deeper than the inner, but is more prolonged distally—perhaps the most distinctive avian character of the bone. *Colymbus* is the only existing bird to which the fossil makes any approximation, but the resemblance is distant and not suggestive of near affinity, and it is interesting that the cretaceous birds show so marked an affinity with that type. The resemblances of the dinosaurian and crocodilian femora with this type are such that almost every individual feature of the bone can be paralleled in some fossil referable to these groups, but there are no British dinosaurs of so small a size or possessing some of the marked features shown by this bone.—Notes on the rhyolites of the Hauraki Goldfields (New Zealand), by James Park and Frank Rutley; with analyses by Philip Holland. Part i. of this paper, by Mr. J. Park, gives a description of the rhyolites as seen in the field. After a rest from volcanic action during the secondary period, the tertiary eruptions burst forth and were more widespread than those of recent times. In the Hauraki Peninsula, the basement palæozoic rocks are covered by richly fossiliferous marly clays and limestone of Lower Eocene age, and these by a vast accumulation of andesitic lavas and tuffs, in places 3000 feet thick. These andesites are the gold-bearing rocks of the district, and they are succeeded by rhyolitic lavas and ashes. Both andesites and rhyolites were influenced by solfataric action, resulting in siliceous deposits rich in gold and silver. The rhyolites rest on rocks probably of Upper Miocene age, and are followed by Pleistocene and recent deposits; so that they probably range from older to newer Pliocene in date. Part ii. contains the observations of Mr. Rutley on the petrology of the rhyolites. The rocks present occasional occurrences of perlicity, and the lithoidal types sometimes owe their characters to subsequent devitrification, sometimes to the effect of cooling on, or immediately after, eruption. Reheating has at times reduced the felspars to the condition of felspar-glass. Although plagioclase-felspar is common, the analyses indicate that the series must be retained with the rhyolites, it being quite possible that some of these minerals may have been derived from the andesites.—On the progressive metamorphism of some Dalradian sediments in the region of Loch Awe, by J. B. Hill, R.N. (communicated by Sir A. Geikie, F.R.S.). The region under discussion contains two principal series of rocks, passing one into another without a break, and conveniently referred to the Dalradian System: (1) The Ardrishaig Series (phyllites and fine-grained quartzites). (2) The Loch Awe Series (black slates, limestones, grits, and quartzites). The latter series lies in a gentle trough of the former. Even in their most altered state, the clastic nature of the rocks of the Loch Awe Series is apparent. Both series are pierced by innumerable intrusive sills of epidiorite, hornblende-schist, and chlorite-schist, modified diorites and gabbros, which effect contact-metamorphism in the bordering sediments. Intrusive rocks of post-schistose date also occur, like the Glenfyn granite, the granite of Ben Cruachan, and smaller masses of granite, monzonite, hyperite, ultrabasic rocks, quartz-porphyries, felspar-porphyries, porphyrites, and lamprophyres; these are in their turn cut by dolerite and basalt-dykes. All these rocks exhibit progressive metamorphism when traced towards the north-east and towards the Central Highlands, a character best seen in the loop formed by the rocks near the head of Loch Awe. Although the author does not go very fully into the question of the causes of the progressive metamorphism exhibited in tracing these rocks towards and into the Central Highland schists, he had reason to suspect that "the intense regional type of metamorphism was linked with the same phenomena that afterwards resulted in the irruption of the granite-masses."

PARIS.

Academy of Sciences, May 29.—M. van Tieghem in the chair.—On isothermal surfaces, by M. Gaston Darboux.—On the laws of pressures in guns, by M. Vallier. A theoretical discussion of the distribution of pressure from point to point of the barrel during firing.—On cyclic pencils which contain a system of geodesics, by M. C. Guichard.—On the series of Dirichlet, by M. Lerch.—On the true polarisation of dielectrics placed within an electric field, by M. H. Pellat. The hypothesis is advanced that polarisation is not instantaneous; but that a dielectric, solid or liquid, placed suddenly in an electric field, takes a polarisation which increases with the time, reaching a maximum asymptotically. If the field ceases, the polarisation decreases gradually, becoming zero at the end of a certain time, theoretically infinite. The results of an experimental study are in agreement with this hypothesis.—Polymerisation of abnormal vapours: nitrogen peroxide and acetic acid, by M. A. Leduc. In a previous paper, the author has shown that the variations in the density of chlorine with temperature are in perfect agreement with the theory of corresponding states, and the assumption that a dissociation of chlorine molecules has taken place is unnecessary. An application of the same method to the cases of nitrogen peroxide and acetic acid shows that the molecule is clearly dissociated. — On the measurements, in terms of a wave-length as unit, of a quartz cube, of 4 cm. length of side, by MM. Ch. Fabry, J. Macé de Lépinay, and A. Perot. The measurement was effected by means of the interferential method previously described, the variations between the individual readings being of the order of 1 in 1,000,000.—Bravais points and poles, by M. Pierre Lefebvre.—On the estimation of hydrogen phosphide in gaseous mixtures, by M. A. Joannis. A solution of copper sulphate cannot be employed to estimate hydrogen phosphide in gaseous mixtures, except in the absence of gases absorbable by copper salts. The copper sulphate solution must always be employed in considerable excess.—Separation and estimation of traces of chlorine in presence of a very large excess of bromide, by M. H. Baubigny. The method of copper sulphate and potassium permanganate is employed, and analyses of samples of potassium bromide sold as pure showed that a trace of chlorine was invariably present, 0·1 per cent. of chlorine being the minimum.—Properties of some mixed haloid salts of lead, by M. V. Thomas.—On the quantitative separation of cerium, by MM. G. Wyrouboff and A. Verneuil. The method suggested is based upon the solution of the mixture of oxides in nitric acid, and subsequent polymerisation of the oxide in presence of sulphuric acid. The test analyses given are very satisfactory.—The enantiomorphic structure of *l*- and *r*-benzylidene-camphors as revealed by corrosion figures, by M. Minguin.—Mixed combinations of phenylhydrazine and another organic base with certain metallic salts, by M. J. Moitessier.—Study of some oxymethylenic derivatives of cyanacetic ethers, by M. E. Grégoire de Bollemont.—Centrosome and fecundation, by M. Félix Le Dantec.—On the variations and specific grouping of the American Peripatæ, by M. E. L. Bouvier.—Spontaneous asphyxia and the production of alcohol in the deeper tissues of ligneous stems under natural conditions, by M. Henri Devaux. A study of the respiratory coefficients of the internal layers of certain plant stems showed that the ratio CO_2/O_2 increases rapidly with the temperature. This increase of carbon dioxide, according to the

author, can only arise from a true fermentation, and in accordance with this view alcohol was obtained from such stems.—The guidroa, the caoutchouc tree of Madagascar, by M. Henri Jumelle. An examination of the guidroa showed that it clearly belongs to the genus *Mascarenhasia*; but, as it does not exactly agree with any of the fifteen or sixteen species actually known, the name *M. velutina* is proposed for the plant.—On the parasitism of *Ximenia americana*, by M. Edouard Heckel.—On some rhyolites from Somaliland, by M. A. Lacroix.—On the eruptive rocks of Cape Blanc (Algeria), by MM. L. Duparc and E. Ritter. Microscopic and chemical examination of the volcanic rocks of Cape Blanc show them to be neo-volcanic quartz-porphyry of a basic character.—On the existence in the blood of animals of a substance preventing the coagulation of milk, by M. A. Briot. Blood serum from the horse contains a substance capable of neutralising the effects of a certain quantity of rennet. This substance is of a diastatic nature, since it cannot be dialysed, is destroyed by heat, and can be precipitated by ammonium sulphate and by alcohol.

DIARY OF SOCIETIES.

THURSDAY, JUNE 8.

ROYAL SOCIETY, at 4.30.—Meeting for Discussion.—*Subject*: On Preventive Inoculation: introduced by M. Haffkine.

MATHEMATICAL SOCIETY, at 8.—On Solitary Waves, Equivoluminal and Irrotational, in an Elastic Solid: Lord Kelvin, G.C.V.O.—On Several Classes of Simple Groups: Dr. G. A. Miller.—The Transmission of Stress across a Plane of Discontinuity in an Isotropic Elastic Solid and the Potential Solutions for a Plane Boundary: Prof. J. H. Michell.—On Theta Differential Equations and Expansions: Rev. M. M. U. Wilkinson.—Finite Current Sheets: J. H. Jeans.—On a Congruence Theorem having reference to an Extensive Class of Coefficients; and on a Set of Coefficients analogous to the Eulerian Numbers: Dr. Glaisher, F.R.S.—(1) The Reduction of a Linear Substitution to its Canonical Form; (2) On the Integration of Systems of Total Differential Equations: Prof. A. C. Dixon.

FRIDAY, JUNE 9.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Further Investigation concerning the Position Error affecting Eye-Estimates of Star Magnitudes: A. W. Roberts.—Equatorial Comparisons of Jupiter, Uranus and Neptune with certain Stars in Newcomb's Standard Catalogue: John Tebbutt.—Note on the Nebula N.G.C. 6535: W. H. Robinson.—*Probable Paper*: An Ephemeris of Two Situations in the Leonid Stream: G. Johnstone Stoney.

PHYSICAL SOCIETY, at 5.—On the Distribution of Magnetic Induction in a Long Iron Bar: C. G. Lamb.—On the Absolute Value of the Freezing-Point: J. Rose-Innes.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of *Unio* from the River Pahang: E. A. Smith.—Notes on Holocene Deposit at the Horseshoe Pit, Colley Hill, Reigate: Rev. R. Ashington Bullen.—Anatomical Notes on *Medyla insculpta*, Pfr.: Henry Suter.

SATURDAY, JUNE 10.

ECOLOGISTS' ASSOCIATION.—Excursion to Rickmansworth and Harefield. Directors: W. Whitaker and John Hopkinson.

MONDAY, JUNE 12.

RÖNTGEN SOCIETY, at 8.—Portable Röntgen Apparatus, for Field and Ward Work, to be demonstrated and described by Major Beevor, J. Hall Edwards, and H. W. Cox.—A New Stereoscope to be demonstrated for Mr. Gregory by F. W. Watson Baker.—Dr. Walsh will also show a New Stereoscope.

TUESDAY, JUNE 13.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prehistoric Man in the Neighbourhood of the Kent and Surrey Border: Neolithic Age: George Clinch.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Acetylene: Prof. Vivian B. Lewes.

THURSDAY, JUNE 15.

ROYAL SOCIETY, at 4.—Prof. A. Michelson will read a Paper.—The Colour Sensations in Terms of Luminosity: Captain Abney, F.R.S.—A Comparison of Platinum and Gas Thermometers at the International Bureau of Weights and Measures at Sévres: Dr. J. A. Harker and Dr. P. Chappuis.—On a Quartz-Thread Gravity Balance: R. Threlfall, F.R.S.—On the Orientation of Greek Temples, being the Results of some Observations taken in Greece and Sicily, in May, 1898: F. C. Penrose, F.R.S.—A Preliminary Note on the Life-History of the Organism found in the Tsetze Fly Disease: Dr. H. G. Plimmer and Dr. T. Rose Bradford, F.R.S.—And other Papers.

LINNEAN SOCIETY, at 8.—Contributions to the Natural History of Lake Urmi and its Neighbourhood: R. T. Günther.—A Systematic Revision of the Genus Najas: Dr. A. B. Rendle.—On the Anatomy and Systematic Position of some Recent Additions to the British Museum Collection of Slugs: Walter E. Collinge.—The Edwardsia Stage of Lebrunia, and the Formation of the Œsophagus and Gastro-cœlomic Cavity: J. E. Duerden.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—On the Decomposition of Chlorates, with special reference to the Evolution of Chlorine and Oxygen: W. H. Sodeau.—The Action of Hydrogen Peroxide on Formaldehyde: Dr. A. Harden.—Homocamphoronic and Camphononic Acids: A. Lapworth and E. M. Chapman.—Action of Silver Compounds on α-Dibromocamphor: A. Lapworth.—The Colouring Matter of Cotton Flowers: A. G. Perkin.—Experiments on the Synthesis of Camphoric Acid: H. A. Auden, W. H. Perkin, jun., and J. L. Rose.—Methylisoamylsuccinic Acid, Part I.: W. T. Lawrence.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Hereford Earthquake of December 17, 1896: Dr. C. Davison (Birmingham, Cornish).—Physikalisches Praktikum: E. Wiedemann u. H. Ebert, Vierte Auflage (Braunschweig, Vieweg).—Tables for Quantitative Metallurgical Analysis: J. J. Morgan (Griffin).—Royal University of Ireland Exam. Papers, 1898 (Dublin).—Year-Book of Photography (9 Cecil Court).—A Country Schoolmaster: James Shaw, edited by Prof. R. Wallace (Edinburgh, Oliver).—I Batteri Patogeni: Dr. N. Ottolenghi (Torino, Rosenberg).—Sieroterapia e Vaccinazioni Preventive contro la Peste Bubbonica: Dr. A. Lustig (Torino, Rosenberg).—The Elements of Practical Astronomy: W. W. Campbell, 2nd edition (Macmillan).—Bergens Museum. Report on Norwegian Marine Investigations, 1895-97: Hjort, Nordgaard, and Grann (Bergen).—List of the Genera and Species of Blastoidea in the British Museum (Natural History) (London).—Chimie Végétale et Agricole: Prof. Berthelot, 4 Vols. (Paris, Masson).—Sewer Design: H. N. Ogden (Chapman).—The Steam Engine and Gas and Oil Engines: Prof. J. Perry (Macmillan).—The Dog: edited by Piepe and Furneaux (Philip).—An Account of the Deep-Sea Ophiuroidea collected by the R.I.M.S. Ship *Investigator*: R. Koehler (Calcutta).—Traité Élementaire de Mécanique Chimique: Prof. P. Duhem, Tome iv. (Paris, Hermann).—U.S. Geological Survey, 18th Annual Report, Part 2, Part 5 (Washington).

PAMPHLETS.—Die Methode der Variationsstatistik: G. Duncker (Leipzig, Engelmann).—Das Hypsometer als Luftdruckmesser, &c.: H. Mohn (Christiania, Dybwad).—Summary Report of the Geological Survey Department, 1898 (Ottawa).—Mauritius Magnetical Reductions: T. F. Claxton (Mauritius).—Protokoll über die vom 31 März bis 4 April, 1898 zu Strassburg i.E. abjgehaltene erste versammlung der Internationalen Aëronautischen Commission (Strassburg).—Picture Taking and Picture Making (Kodak Press).—Natural History of the Musical Bow: H. Balfour, Primitive Types (Oxford, Clarendon Press).—Thatsachen und Auslegungen in Bezug auf Regeneration: A. Weissmann (Jena, Fischer).—La Navigation a Vapeur sur le Haut Yang-Tse: R. P. S. Chevalier (Chang-Hai).

SERIALS.—Journal of the College of Science, Imperial University of Tokyo, Japan, Vol. xi. Part 2 (Tokyo).—Proceedings of the Washington Academy of Sciences, Vol. i. pp. 15-106 (Washington).—Johns Hopkins University, Studies in Historical and Political Science, Series xvii. Nos. 4 and 5 (Baltimore).—Monthly Weather Review, February (Washington).—Boletim do Musen Paraense, December (Pará).—Società Reale di Napoli, Atti della Reale Accademia delle Scienze Fisiche e Matematiche, serie ii. Vol. ix. (Napoli).—Contemporary Review, June (Isbister).—Century Magazine, June (Macmillan).—Humanitarian, June (Duckworth).—Photogram, June (Dawbarn).—Knowledge, June (Witherby).—Journal of the Chemical Society, June (Gurney).—Journal of the Marine Biological Association, June (Dulau).—Middlesex Hospital Journal, May (London).—Zeitschrift für Physikalische Chemie, xxix. Band, 1 Heft (Leipzig).—Journal of Botany, June (West).—Madras Government Museum, Bulletin Vol. 2, No. 3 (Madras).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Parts 16 to 20 (Gurney).—Fortnightly Review, June (Chapman).—Scribner's Magazine, June (Low).—Anglo-American Magazine, June (Anglo-American Publishing Company).

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